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# **BASIC ORGANIZATION OF THE CARDIOVASCULAR LABORATORY**

**November 1975**

**Final Report for Period July 1972 - July 1974**

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**USAF SCHOOL OF AEROSPACE MEDICINE  
Aerospace Medical Division (AFSC)  
Brooks Air Force Base, Texas 78235**

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This technical report has been reviewed and is approved for publication.

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## BASIC ORGANIZATION OF THE CARDIOVASCULAR LABORATORY

### INTRODUCTION

The aim of this report is to help the cardiologist or radiologist organize and manage a cardiovascular laboratory and train the personnel to provide effective support. The physician must be able to rely on well trained and disciplined personnel to perform many duties basic to the safe and efficient accomplishment of diagnostic catheterizations. These duties include: maintaining sterile techniques; assuring that the proper surgical instruments and catheters are available and in good condition; checking and operating the equipment; and assisting during the actual procedure. These practical points, intrinsic to the organization of any cardiovascular laboratory, are seldom taught. Hopefully, therefore, this report will help the physician who is responsible for a cardiovascular laboratory to become as knowledgeable and competent in supervising all the related areas as he is in accomplishing the specialized catheterization techniques.

### PERSONNEL AND RESPONSIBILITIES IN THE CARDIOVASCULAR LABORATORY

Various combinations of personnel may be used in the cardiovascular laboratory. The most desirable combination includes (in addition to the cardiologist) a nurse, circulating technician, x-ray technician, electronics technician, and scrub technician. The most competent and meticulous person within the group should be placed in charge of the day-to-day operation of the laboratory and should be answerable only to the supervising physician.

#### The Nurse's Responsibilities

Many cardiovascular laboratories have the advantage of a nurse designated to support the laboratory directly. Experience has shown this arrangement to be ideal; but, if it is not possible, then her duties must be assigned to other individuals. In almost any situation, however, nurses are involved in the pre- and postcatheterization care of patients. The nurse functioning as part of the cardiovascular team has the following duties:

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EDITOR'S NOTE: Throughout this publication, illustrations (figures, tables, and forms) are grouped at the close of the respective report section in which they are first mentioned.

## --PERSONNEL AND RESPONSIBILITIES--

The day before the procedure, the nurse talks with the patient to establish rapport and confidence, to reinforce the physician's explanations and instructions, and to witness the permit. The nurse makes certain that the precatheterization laboratory studies are performed, and that all test results and information (such as a history of drug allergies) are available for the physician.

In the laboratory, before the catheterization, the nurse personally checks all emergency equipment to insure it is operating, prepares the necessary intravenous solutions, and supervises the availability and administration of all medications.

During the catheterization, the nurse closely observes the patient--maintaining personal contact so that any change in the patient's condition can be noted and brought to the attention of the physician. The rapport that the nurse has established with the patient is most helpful in lessening anxiety and insuring good cooperation. The nurse, if not scrubbed, maintains the Cardiovascular Laboratory Flow Sheet (Form No. 1), keeping track of the duration and sequence of events. The nurse may also scrub and assist the physician, performing the duties listed under "Scrub Technician."

### The X-ray Technician's Responsibilities

The x-ray technician must be knowledgeable in the operation of all the x-ray equipment and in the development of x-ray film. He must obtain the best performance from the available equipment. He must also closely monitor quality control, and initiate periodic maintenance as well as immediate adjustments when needed.

He performs the precatheterization x-ray equipment check, measures the patient's chest, and adjusts the equipment for optimal performance. During the procedure, he manages the fluoroscopy unit, video tape recorder, film changers, x-ray tubes, cine cameras, and video monitors. He carefully checks the amount of film footage remaining in the cine camera and keeps the physician informed. He monitors and records fluoroscopy time. When the case is completed, he should be able to develop the film competently and prepare it for viewing by the physician. These duties require a thorough knowledge of various film types and developing techniques.

### The Scrub Technician's Responsibilities

The scrub technician drapes the patient, sets up the sterile table and necessary trays, and positions the transducers, solution lines, and manifolds.

He gowns and gloves the physician and assists him during the catheterization. Through experience, the scrub technician learns to anticipate the physician's needs and can greatly facilitate the procedure.

## --PERSONNEL AND RESPONSIBILITIES--

### The Electronic Technician's Responsibilities

The electronic technician prepares the recording system and checks its operation. Before the procedure, he must: balance and calibrate pressure transducers and all other measuring devices; apply the ECG leads and see that good tracings are obtained; monitor the cardiac rhythm and pressure curves during the procedure and immediately notify the physician of changes. From the pressure curves, he recognizes and calls out wedging and damping, as well as the intravascular site of the catheter. Premature ventricular contractions (PVCs) should be called out by number. When the case is completed, he prepares the recordings for the physician, as well as a work sheet indicating the scale, the recording speed, and the site where the recording was taken. The electronic technician supervises the monthly electrical equipment safety checks and maintains these records (consult report section on: "Electrical and Radiation Safety"). He also, at least monthly, calibrates the pressure transducers with a mercury manometer and records their calibration factor.

### The Circulating Technician's Responsibilities

Ideally, an individual should be available who knows how to operate the ancillary equipment in the laboratory (such as the contrast media injector and oximeter). He can help with moving equipment into place for specialized procedures, and with getting any additional instruments or equipment needed during the procedure.

### The Charge Technician's Responsibilities

The charge technician fills a supervisory role. Of course, all of the individuals who perform the jobs already outlined work as a team and, ideally, should be able to interchange roles. (This interchange is advantageous for laboratory efficiency during periods of illnesses or vacations.) It is best, however, that one of these individuals function as the leader. He or she, as charge technician, supervises all the other team members and sees that their duties are properly carried out. Scheduling of cases, technician work and rotation schedules, and on-the-job training are controlled by this technician. Other duties include: ordering and maintaining supplies, performing a weekly inventory, and removing out-dated supplies. The charge technician also takes and records the results of appropriate culture checks of sterilization, and assures that the appropriate standards for cleanliness are maintained.

### The Team Responsibilities in Emergency Situations

Outlined in Table 1 are the respective roles of the principal team members in emergency situations.

**--PERSONNEL AND RESPONSIBILITIES--**

**FORM NO. 1**

**CARDIOVASCULAR LABORATORY FLOW SHEET**

SS #	NAME (LAST, FIRST, MI)		HOSPITAL #	
DATE	CATH #	AGE	HT	WT
REASON FOR CATH:				
PROCEDURE TIME: Started		Completed	Total	
ARTERIAL TIME: Started		Completed	Total	
PRE-PROCEDURE MEDICATION:			Time Given	

TIME:		TEST
Started	Completed	

REMARKS:	LABORATORY VALUES		
	Hct	Hgb	
	Prothrombin Time:	Pt.	Control
	P.T.T.:	Pt.	Control
	K +	Sickle cell prep.	

CATHETERS USED:	CONTRAST MEDIA:	MEDICATIONS	TIME GIVEN:	ROUTE:



--PERSONNEL AND RESPONSIBILITIES--

TABLE 1. RESPECTIVE ROLES OF MEMBERS OF CARDIAC CATHETERIZATION TEAM  
IN EMERGENCY SITUATIONS

---

1. Cardiologist	Initiates intubation external cardiac massage team direction
2. Nurse	Defibrillation (when required) respiratory assistance Medication administration Patient monitoring Record keeping
3. Circulating technician	Preparation for emergency care and/or transfer emergency; supplies physician and blocks steps emergency notification system; maintains necessary facilities, lighting, supplies; obtains transfer ambulance; notifies Medical Center; emergency room, or cardiac care unit
4. X-ray technician	Levels rotacor Removes tube head from area
5. Electronics technician	Monitors patient Keeps records
6. Scrub technician	Assists physician in external cardiac massage

---

## APPROACH TO THE CATHETERIZATION

### Preparations on the Day Before Cardiac Catheterization

After the physician has carefully and fully explained the catheterization procedure, the patient is taken on a tour of the Cardiovascular Laboratory. The equipment that will be used during the procedure is explained to him in simple terms. Familiarity with the sights and sounds of the laboratory helps preclude many of the anxiety-related problems that might otherwise occur during the procedure. The cardiovascular nurse then sees the patient briefly, answers any further questions, and reemphasizes the doctor's instructions. The nurse also initiates the Catheterization Flow Sheet (Form No. 1--refer to p. 10). In addition, the signed permit is checked, and significant clinical information is noted. The importance of breath holding, without performing a Valsalva maneuver, and coughing on command are also explained to the patient.

In the laboratory, the necessary equipment is prepared for the procedure with the help of checklists (e. g., Form No. 2) and procedure cards. All electrical and mechanical equipment must be checked. The laboratory is damp mopped with a disinfectant each evening before catheterization. The patient's right antecubital fossa and/or right inguinal area can be shaved either the night before, or the morning of, the procedure.

### Essential Steps in the Procedure

In the laboratory, all equipment, counters, sinks, and other surfaces should be damp dusted with a cleaning solution. The electrical equipment, including the transducer, is plugged in and warmed up. All emergency equipment, including drugs, are checked and made ready. The contrast medium is warmed to body temperature. The assistant (nurse or scrub technician) drapes the surgical table and opens the sterile equipment needed for the case while the circulator prepares the injector. As the assistant scrubs, gowns, and gloves himself, the patient arrives and is positioned on the table or rotacor.

The patient's blood pressure and pulse are taken and the right radial, dorsalis pedis, and posterior tibial pulses are circled. After the patient is secure on the rotacor, the movement of the equipment is demonstrated. The ECG leads are placed on both shoulders and legs. Prior to application of the leads, each area is wiped with an alcohol sponge and rubbed with an abrasive. X-ray equipment is then calibrated for the patient's size and the fluoroscopy unit checked for the clarity of the picture. The x-ray technician loads the x-ray equipment and records the patient's identification number, along with the magnification grid. The sterile assistant then sets up all equipment as the circulator scrubs the catheterization site(s). The surgical table is moved into position, and the patient is draped for the procedure planned.

## --APPROACH TO CATHETERIZATION--

The head of the fluoroscopy unit is also draped because it can come into contact with the sterile field. Intravenous solutions are connected to the manifold; and all catheters, needles, tubing, stop-cocks, manifold, and guidewires are wiped, flushed, and inspected. The transducer is attached (via tubing) to the manifold, and the level is adjusted to the patient's mid-chest. The pressure transducer is calibrated and balanced by the electronic technician. The physician is then called to begin the procedure.

After the procedure, the sutured antecubital incision is cleaned and antibiotic ointment applied under a 4 X 4-in. gauze dressing. A slight pressure is maintained with the use of a 2-in. Ace bandage (Fig. 1:A-C). Before application of this dressing, the right radial artery is checked for fullness. In addition, this pulse is compared to the left radial pulse. The nail beds are checked for capillary filling; the hand is checked for temperature and strength, and finally the patient is questioned with regard to symptoms.

When a percutaneous approach to the femoral artery has been done, pressure is held on the puncture site for 10 min beginning as the catheter is removed (Fig. 2:A). A pressure dressing is applied, utilizing elastoplast adhesive (Fig. 2:B-D). To prevent patient discomfort, the leg is shaved to mid-thigh before the dressing is applied, and liquid adhesive protector is used under the tape. When the entire procedure has been accomplished, the postprocedure checklist is filled out (Form No. 3).

The patient is ready for transfer to his room as soon as he is considered stable. Patients who have had a right brachial artery approach usually can be transferred by a wheelchair--but those who have had a percutaneous femoral arterial approach are transferred by stretcher. After either approach, the patient is told that he may freely use his right hand and move his arm. Marked flexion and extension are discouraged, as well as lying on the arm. After a brachial artery procedure, the patient can be allowed to ambulate as soon as the effects of medications have worn off. For patients who have undergone a femoral artery approach, bed rest without weight bearing is recommended for 18 - 24 hr.

The routine catheterization patient is able to leave the hospital the morning after the procedure. At that time, a small bandage should be applied over the operative site, and the patient should be given possible instructions about suture removal and observation for possible complications.

--APPROACH TO CATHETERIZATION--

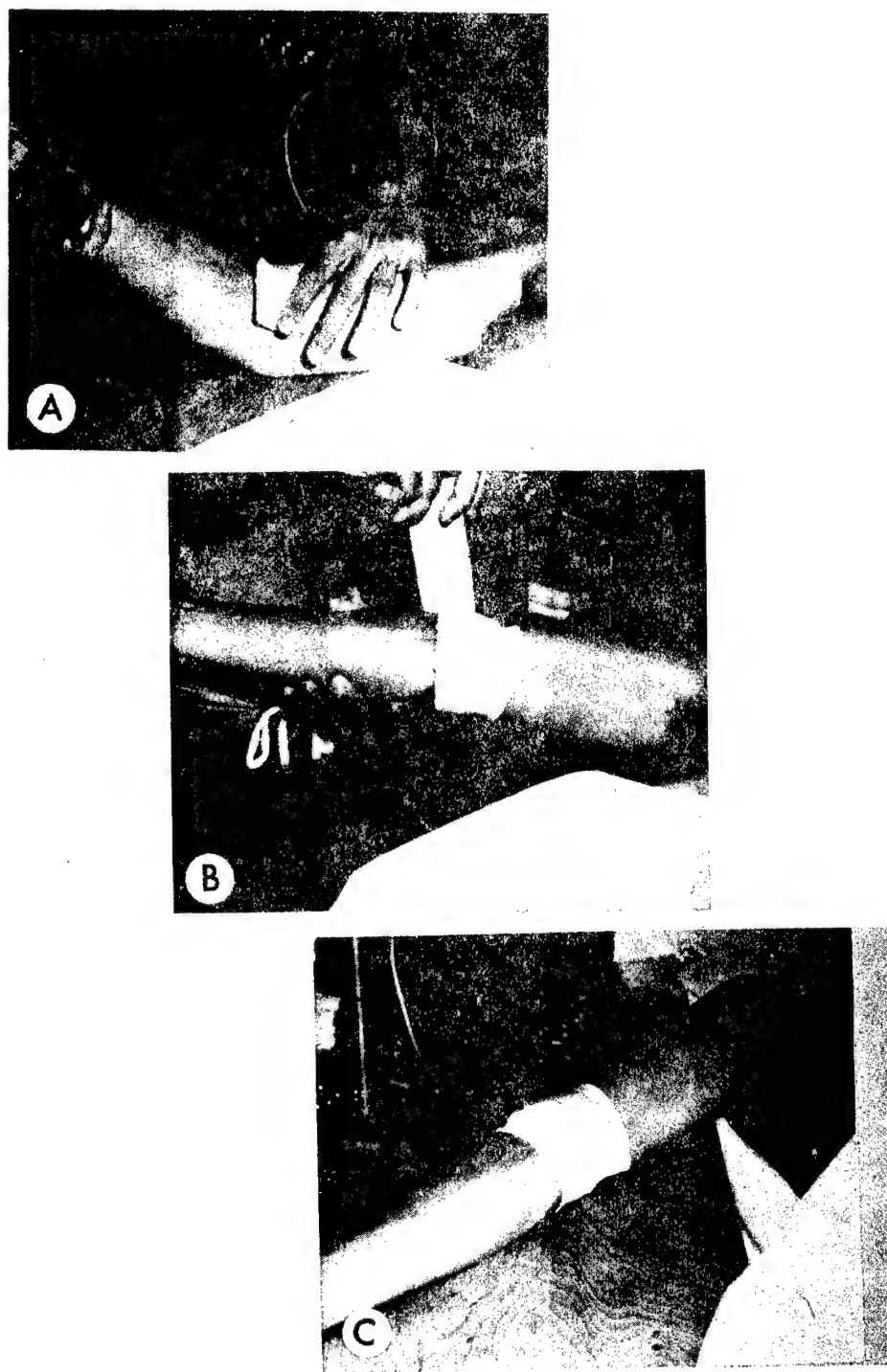


Figure 1. Dressing the right antecubital incision site.

--APPROACH TO CATHETERIZATION--



Figure 2. Pressure dressing to the right inguinal percutaneous site. (Cont'd on facing page)

--APPROACH TO CATHETERIZATION--

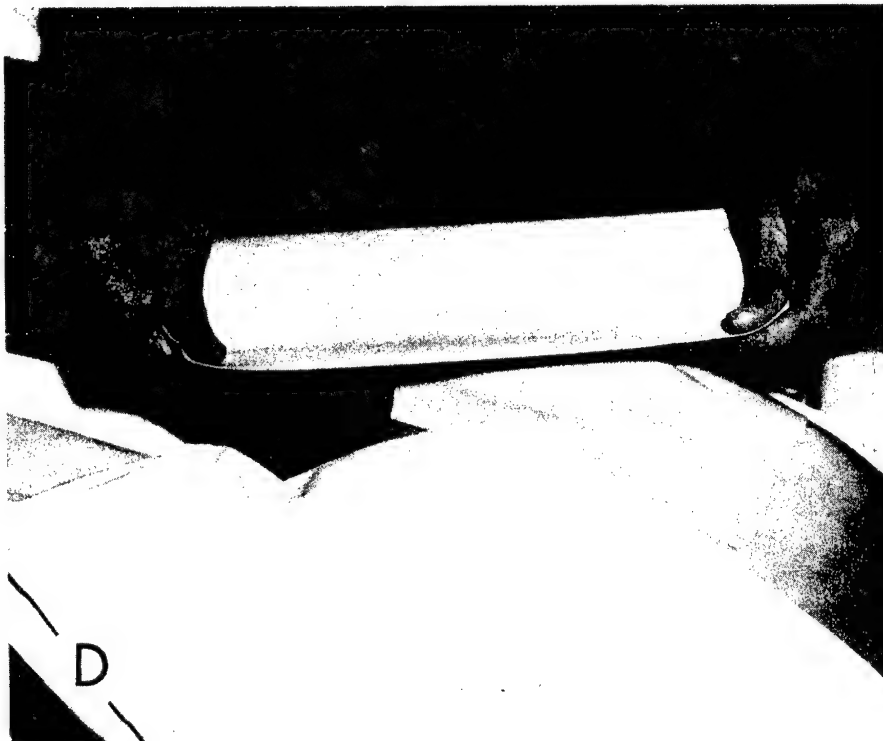
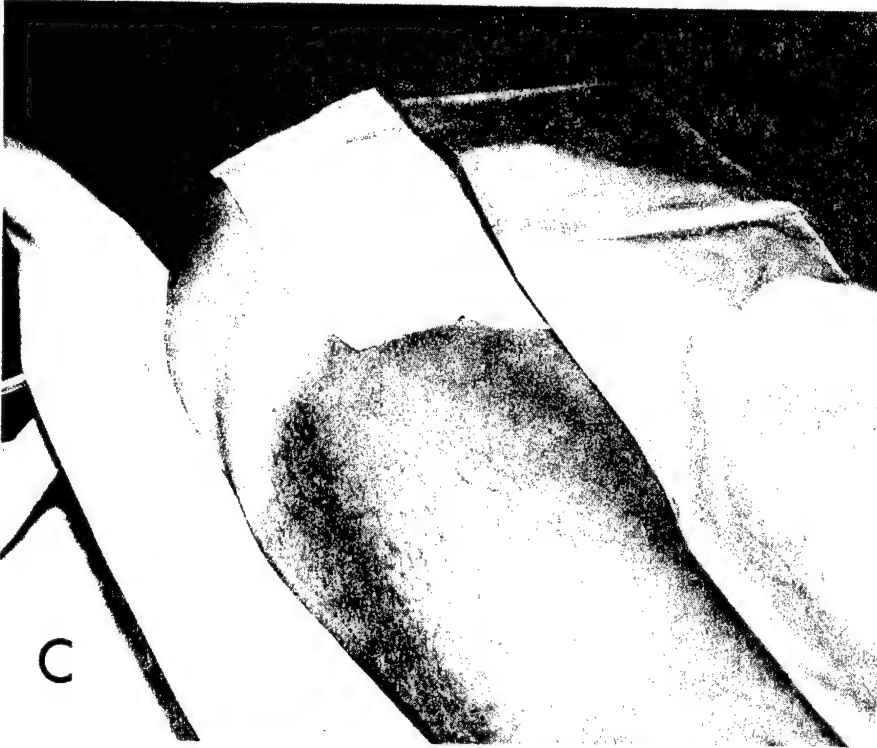


Figure 2 (Cont'd)

--APPROACH TO CATHETERIZATION--

FORM NO. 2

OPERATING CHECKLIST FOR THE CARDIAC CATHETERIZATION LABORATORY

Name:

SSN:

Date:

Admitting Diagnosis:

Equipment	Day	Cath	Remarks
	Pre Cath	Day	
1. X-ray-----			
2. Video tape recorder-----			
3. Oscilloscope-----			
4. TV monitor #1-----			
5. TV monitor #2-----			
6. Light on table-----			
7. TV camera-----			
8. X-ray badges-----			
9. X-ray aprons-----			
10. Cine camera-----			
11. Cine case and film-----			
12. Film developer and solution-----			
13. X-ray badge report (Date in "Remarks")-----			
14. Floor conductivity report (Date)-----			
15. Clock-----			
16. Rotacor-----			
17. Renografin warmer-----			
18. Catheter basin-----			
19. Pressure and ECG recorder-----			

(Cont'd on facing page)

--APPROACH TO CATHETERIZATION--

Form No. 2 (Cont'd)

Equipment	Day	Cath	Remarks
	Pre Cath	Day	
20. Routine electrodes-----			
21. Special electrodes-----			
22. Transducer-----			
23. Level of transducer-----			
24. His junction box-----			
25. Harvard pump-----			
26. Cordis injector-----			
27. Defibrillator (in lab)-----			
28. Defibrillator (portable unit)-----			
29. External pacemaker-----			
30. Sterile pace cord-----			
31. Unsterile pace cord-----			
32. Oxygen equipment-----			
33. Backup oxygen tank-----			
34. Suction equipment-----			
35. Intubation equipment-----			
36. Emergency lights-----			
37. Room lights-----			
38. Fire-fighting equipment-----			
39. Cardiac massage equipment-----			
40. Steps for patient-----			
41. Step for doctor-----			

(Cont'd on next page)



--APPROACH TO CATHETERIZATION--

Form No. 2 (Cont'd)

Equipment	Day	Cath	Remarks
	Pre Cath	Day	
42. Emergency phone-----			
43. Door sign-----			
44. Single ring stand and basins-----			
45. Mayo stands (2)-----			
46. Kidney-shaped cath table-----			
47. Emergency drugs-----			
48. Refrigerated drugs-----			
49. I.V. solutions-----			
50. Non-I.V. solutions-----			
51. Contrast media (50 ml)-----			
52. Contrast media (200 ml)-----			
53. Used needle and syringe container-----			
54. Patient prep tray-----			
55. Patient scrub tray-----			
56. Routine catheters-----			
57. Special catheters-----			
58. Emergency catheters-----			
59. Sterile equipment for case-----			
60. Caps, masks, gowns, etc., for staff-----			
61. Scrub equipment for staff-----			
62. Linen (unsterile)-----			
63. Linen hamper-----			

(Cont'd on facing page)

--APPROACH TO CATHETERIZATION--

Form No. 2 (Cont'd)

Equipment	Day Pre Cath	Cath	Remarks
64. Garbage bags-----			
65. Garbage cans-----			
66. Clean room-----			
67. Cleaning equipment for room-----			
68. Floor clean (contract)-----			
69. Bacteriological report-----			
70. Blood pressure cuff-----			
71. Stethoscope-----			
72. Flashlight-----			
73. Kidney basin-----			
74. Urinal-----			
75. Keys for cabinets-----			
Room checked by _____			

--APPROACH TO CATHETERIZATION--

FORM NO. 3

POSTPROCEDURE CHECKLIST

Equipment	Done	Not Done	Remarks
1. Used supplies removed-----			
2. Catheter care-----			
3. Supplies restocked-----			
4. Medications reordered-----			
5. Machines turned off:			
A. X-Ray-----			
B. Suction-----			
C. Oxygen-----			
D. Defibrillator-----			
E. Pressure and ECG recorder-			
F. Warmer-----			
G. Camera-----			
H. Cordis Injector-----			
I. Harvard Pump-----			
6. Cabinets locked-----			
7. Sign taken down-----			
8. Portable defibrillator to unit--			
9. Room clean-----			
10. Garbage in bags-----			

Area checked by \_\_\_\_\_

## STERILE TECHNIQUE IN THE CARDIOVASCULAR LABORATORY

The following steps are outlined for the members of the cardiovascular laboratory who are to enter the sterile field of the catheterization procedure. First, each individual puts on clean scrub pants, shirt, hat, and mask. Sleeves are well above the elbows, and the scrub shirt is tucked into the pants. The hair must be short and/or adequately covered. If glasses are worn, the mask is taped to the bridge of the nose to prevent their fogging. Watches, rings, and other jewelry are removed. Two x-ray film badges are positioned: one external at the neck level, and the other at the belt level under the lead apron (Fig. 3).

### Scrubbing

The initial scrub of the day is 10 min, with short scrubs of 3 - 5 min being used thereafter between procedures. The lead apron is put on before scrubbing. The water flow and temperature are adjusted with a knee (or elbow) lever (Fig. 4:A,B). The hands and arms are given a preliminary washing, then the nails are cleaned under running water with a nail file or nail stick, and the hands rinsed (Fig. 4:C). A sterile cleansing pad is taken from the dispenser and moistened with water. Each hand is scrubbed for 3 min, and each arm for 2 min. The individual concentrates on all four sides of each finger, between fingers, and across knuckles. Circular motions are used over the back of the hands, palms, and wrists (Fig. 4:D,E). The cleansing pad is discarded and the scrubbed hands are held higher than the elbows to prevent water from dripping onto the hands. The fingers, hand, arm and elbow are rinsed with the hands held higher than the elbows and with the arms away from the body (Fig. 4:F,G)--again, allowing water to drip only toward the elbow. The scrubbed individual then proceeds to the Cardiovascular Laboratory, passing backward through swinging doors (Fig. 4:H,I). The short scrub procedure is exactly the same as for the long one, except that scrubbing time is shortened by approximately half.

The scrubbed technician reaches into the sterile towel package and picks up the folded hand towel, without allowing it to drag along the edge of the wrapper from which it is removed (Fig. 5:A). Care is taken to avoid dripping water onto the contents of the pack. He steps back from the table and leans slightly forward, so that the towel unfolds in an area where it will touch nothing but the hands (Fig. 5:B,C). One end of the towel is used to dry one hand and arm. The towel is moved gradually toward the elbow without any retracing of motion toward the hand. The bare hand should not touch the bare arm. The other hand is dried with the opposite end of the towel; the towel is then discarded into the kick bucket.

## --STERILE TECHNIQUE--

### Gowning--Self

In gowning oneself, the following procedure is used. Immediately after the scrubbed hands are dried, the gown is grasped in one hand, and is lifted directly upward to avoid the edge of the sterile package (Fig. 5:D). Stepping away from unsterile objects gives a wide margin of safety for the gown to unfold (Fig. 5:E). (If the top end of the gown should inadvertently be dropped downward, the gown is discarded.) The neckband is held with both hands, and is gently shaken to loosen the folds from the gown. Because all gowns are folded inside out, the slightly upraised hands can be slipped into the armholes without the bare hands touching the outside of the gown (Fig. 5:F). The person circulating reaches inside the gown to the shoulder seam, and pulls the sleeves to the hands (if the closed gloving technique is to be used) (Fig. 5:G); or over the hands (if the open gloving technique is to be used). The person circulating reaches to the bottom of the waist ties to pick them up. The gowned person can be of assistance by leaning forward or by laterally swinging the ties free from the gown (Fig. 5:H). The gown is then tied, touching the outside of the gown at the line of the ties in the back only (Fig. 5:I). The gown is straightened from the hem by the circulating technician (Fig. 5:J).

### Gloving--Closed Method

The left glove is picked up by the sleeve-covered right hand (Fig. 6:A). The left glove is placed over the left hand, palm down, with the fingers toward the elbow (Fig. 6:B,C). The edge of the cuff is grasped with the sleeve-covered right hand. The upper cuff of the glove is lifted up and stretched over the left gown cuff. With the gown and glove being held simultaneously, the hand is pushed through the gown into the glove (Fig. 6:D,E). The right glove is then picked up and placed over the sleeve-covered right hand, palm down, with the fingers toward the elbow; and the same procedure is repeated with the other hand (Fig. 6:F).

### Gloving--Open Method

The right glove is grasped with the left hand, but only the inner surface of the glove is touched (Fig. 7:A). The glove is slipped over the right hand, leaving the cuff folded downward toward the fingers (Fig. 7:B). The gloved right hand is inserted under the cuff of the left glove, which is lifted away from the field (Fig. 7:C). While the gloved right hand is being kept under this cuff, the left glove is pulled over the left hand, keeping the right thumb extended away from the uncovered skin (Fig. 7:D). The left hand is inserted under the right glove cuff which is then unfolded over the gown cuff (Fig. 7:E). The fingers are adjusted and the powder removed with a moistened 4 x 4-in. sponge.

## --STERILE TECHNIQUE--

### Assisted Gowning and Gloving

After the gown has been removed from the pack and allowed to unfold, it is grasped at the shoulder level on the external surface, allowing the excess to cover the sterile gloved hands (Fig. 8:A). The person to be gowned has his arms outstretched in front of him at shoulder level. The sterile gown holder faces the person whose hands are directed into the gown sleeves (Fig. 8:B). The gown is then pushed up to the shoulders, with the person being gowned taking care not to touch the sterile person with the ungloved hands which protrude from the sleeves (Fig. 8:C). The circulating technician then grasps the gown at the back of the neck and fastens the ties (Fig. 8:D). The person being gowned leans forward, or from side to side, to enable the circulator to grasp the ends of the waist ties without touching the gown. The gown is then tied at the waist in the back.

The person being gowned should hold his scrubbed but ungloved hands away from his sterile gown. The sterile assistant takes the right glove, and holds it with the fingers toward the ground and the thumb towards the person being gloved. The sterile assistant places his fingers on the outer surface and under the glove cuff to prevent his gloves from being contaminated. The glove opening is stretched laterally, allowing easier access of the hand into the glove (Fig. 8:E). The glove is held perfectly still while the hand is being pushed into the glove (Fig. 8:F). The left glove is handled in the same manner. The person being gloved may assist by grasping the external surface of the left glove under the cuff with his right hand, further opening the mouth of the glove (Fig. 8:G).

If a glove is contaminated during the procedure, the circulator grasps the glove just above the palm of the hand. Being careful not to touch the gown, he peels the glove over the hand and turns it inside out in the removal process (Fig. 9:A,B). If both gown and gloves are contaminated, the circulator unties the gown from behind and grasps the gown at shoulder level. The gown is pulled over the arms and gloved hands. The cuff of the contaminated glove is grasped and peeled over the hand. The procedure is repeated with the opposite hand. The glove is turned inside out as it is removed (Fig. 10:A-E).

### Shaving and Preparation of the Operative Site

The operative site is prepared at the bedside the night before, or the morning of, the catheterization. The right arm is shaved a minimum of 4 in. proximal and distal to the antecubital crease and medially to the posterior aspect of the arm (Fig. 11). The area to be shaved is cleaned with pHisoHex, and hairs are removed with short strokes against the grain. A safety razor is usually used for the antecubital fossa, due to the sparse hair and also for safety. Once the shaving is completed, the pHisoHex and loose hair are wiped from the

## --STERILE TECHNIQUE--

site with a dry 4 x 4-in. sponge. A piece of masking tape, adhesive side down, is rubbed over the area to remove any small hairs. The right inguinal region is shaved from the midline near the symphysis pubis laterally and at least 6 in. above and 8 in. below the inguinal ligament (Fig. 11). The inner aspect of the thigh is shaved so that an adhesive pressure dressing can be applied painlessly. The thicker hair in the groin is most easily removed with a straight-edge razor.

### Scrubbing of the Operative Site

The circulator dons sterile gloves and soaks a 4 x 4-in. sponge in a solution of pHisoHex and saline. The prep is begun at the incision site and extends outward, in a circular fashion, to the borders of the shaved area. Each sponge is discarded after complete coverage of the operative site. This process is continued for 10 min. The soap is removed and the area dried, using sterile dry 4 x 4-in. sponges in the same motion. Tincture of Zephiran is applied to the scrubbed area with a sponge on a sponge forcep, using the same circular motion, and this area is allowed to air dry before draping.

### Draping--Right Antecubital Area

After the surgical prep, the circulating technician gloves, and takes from the scrub technician a 4-in. stockinette that has been closed at one end and rolled. The patient is asked to extend his fingers and, while keeping his arm straight, lift it from the arm board (Fig. 12:A). The stockinette is carefully rolled down the patient's arm, in order not to drag it over the prepped area (Fig. 12:B). The scrub assistant then rolls the second stockinette over the first, and instructs the patient to continue holding his arm up until a sterile drape can be placed under it (Fig. 12:C,D). The end of the sterile nonabsorbent sheet is passed to the circulating technician, who spreads it over the feet of the patient--while the scrub assistant spreads the upper end over the patient's shoulder and under the prepped arm (Fig. 12:E,F). The patient is asked to relax his arm as the scrub assistant positions it on the covered arm board. The sheet is gathered on each side of the patient's arm as close to the shoulder as possible, and clipped together over the mid-biceps with towel forceps (Fig. 12:G,H). A smaller nonabsorbent drape is positioned over the shoulder and first towel forcep, with the edge being about 4 - 6 in. proximal to the elbow (Fig. 12:I). The patient is again instructed to raise his arm while the leading edge of the drape is fastened snugly around the arm with towel forceps (Fig. 12:J,K). The arm is again positioned on the arm board (Fig. 12:L). The patient should always be asked if the draping is comfortable.

### Draping--Right Inguinal Region

Following the standard surgical prep, a small drape is placed over the patient's genital area to preserve modesty (Fig. 13:A,B). The

## --STERILE TECHNIQUE--

femoral artery is palpated 1 - 2 in. below the inguinal ligament and a small aperture sterile drape is positioned directly over the pulsation (Fig. 13:C). If the femoral vein is to be used, the aperture may be moved slightly medially and distally. The ideal drape has a self-adhesive back which maintains position and sterility during patient rotation. Sterile nonabsorbent drapes are positioned on all 4 sides of the steri-drape, approximately 1 - 1½ in. from the aperture. The sterile drapes are attached to each other and the steri-drapes with towel forceps (Fig. 13:D-F). Draping is continued from this point as described for the arm. At the proper time, this site is exposed by cutting a hole in the covering sheet.

### General Principles of Sterile Technique

Persons who are scrubbed should be careful to touch only sterile articles--just as non-scrubbed team members handle only nonsterile articles or surfaces. All supplies for sterile members are obtained by the circulator. Additions to the sterile table are made as shown in Fig. 14:A,B and in Fig. 15:A-F.

If in doubt about the sterility of an object, consider it nonsterile. For instance, the following would be considered nonsterile: a sterile-appearing package, found in a nonsterile workroom; a sterile table if a nonsterile person brushes close; or a sterile table or article left unguarded and uncovered.

Nonsterile persons should avoid reaching over a sterile field; sterile persons should likewise avoid leaning over an unsterile area. For example, the sterile person places at the edge of the sterile table basins or glasses to be filled.

The sterile person drapes a nonsterile table toward him first; the nonsterile staff member drapes a table away from him first. Tables are only considered sterile at table level; thus linen and sutures falling over the table edge are discarded, and sterile persons do not touch the part hanging below table level. When uncovering a sterile table, care is taken that the bottom edge of the sheet is not drawn up to the table level where it might contaminate the sterile contents. Sterile trays are opened by nonsterile persons (as shown in Fig. 16:A-H).

Gowns are considered sterile from waist to shoulder level in front, as well as sleeves. Gowned and gloved persons must keep their hands at or above waist level but away from the face, with the elbows close to the sides. Arms are never folded, to avoid any perspiration in the axillary area. Articles that are dropped below waist level should be discarded.



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The edge of anything that encloses sterile contents is not considered sterile. (For example, the edges of the wrappers on sterile packages and the caps on solution flasks are not sterile.)

The use of nonabsorbent materials, whenever and wherever possible, cannot be overemphasized. Moisture may cause contamination by soaking through a sterile to a nonsterile area, or the reverse, thus providing a means of transporting bacteria to the sterile area.

Air is contaminated by floating particles. Thus, the following measures are taken to reduce contamination: Masks are worn over the nose and mouth; sneezing and coughing are avoided, and persons with a cold or any active infection are excluded from the laboratory; main corridors are considered contaminated areas; sterile trays without covers are not pushed through corridors; soiled linens are placed at once into laundry bags; and all dusting should be done with a duster moistened with a germicidal solution.

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Figure 3. Proper attire for the cardiac catheterization laboratory.

--STERILE TECHNIQUE--

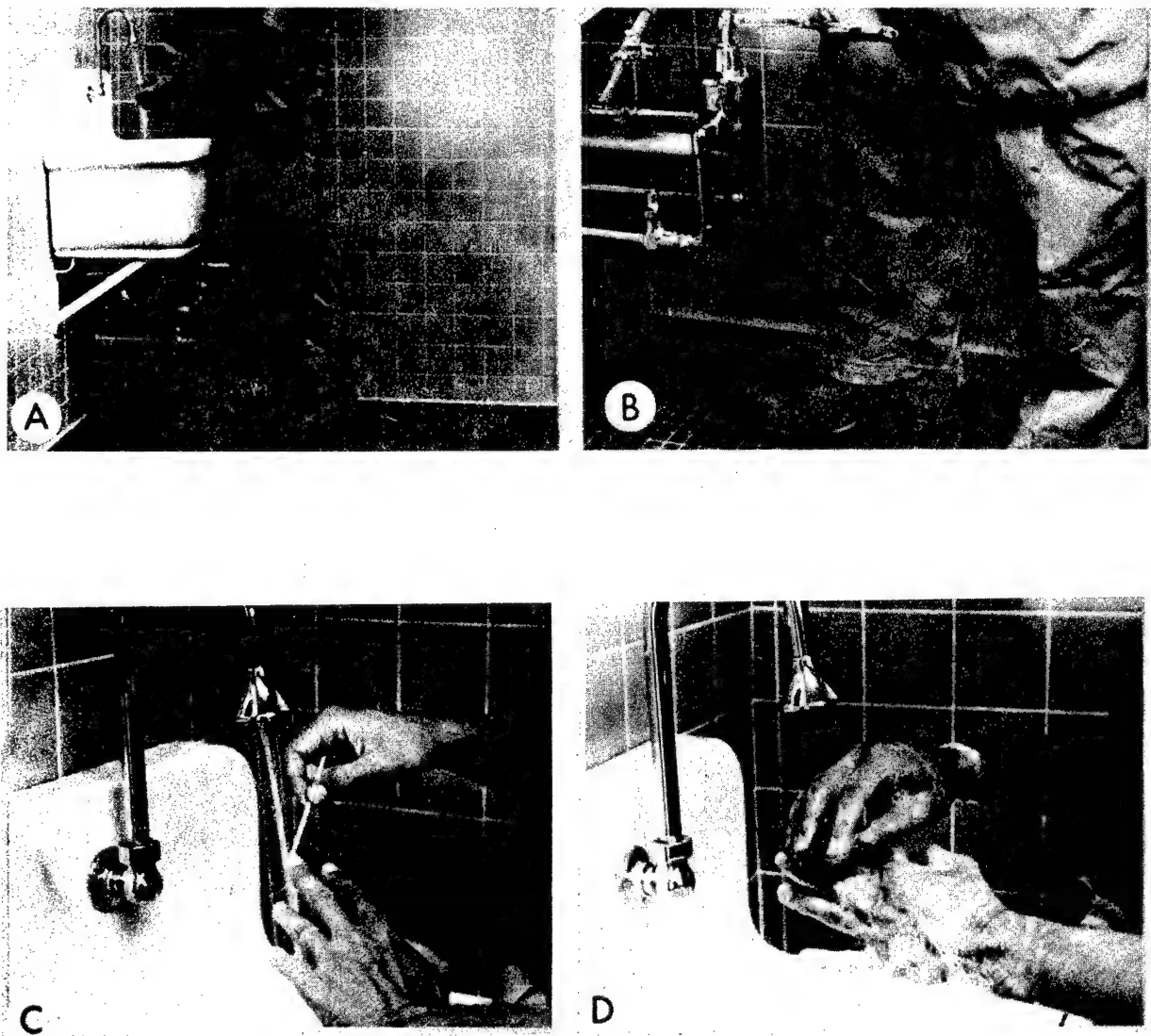


Figure 4. Scrubbing procedures.

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--STERILE TECHNIQUE--



Figure 4. (Cont'd)

--STERILE TECHNIQUE--

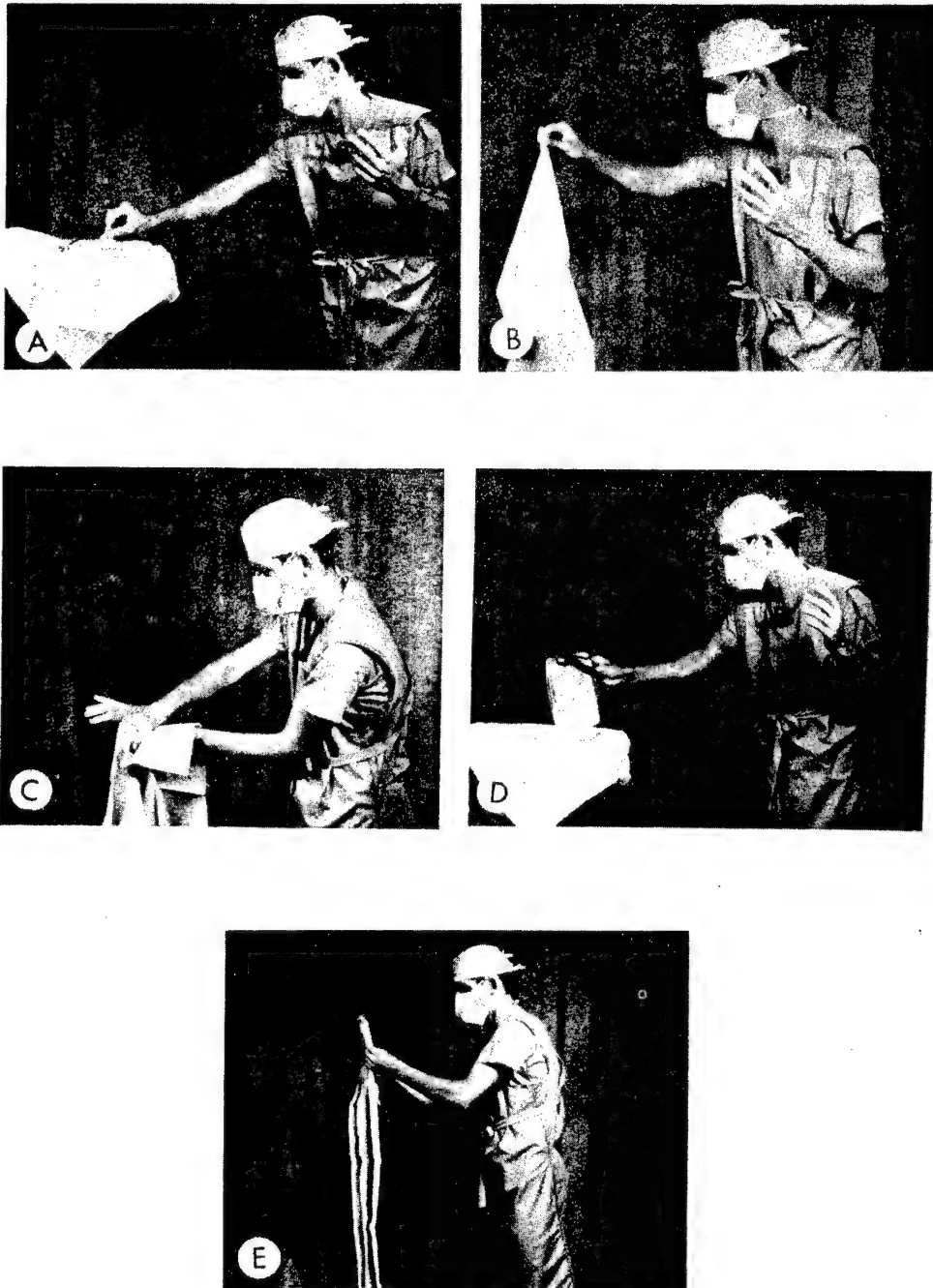


Figure 5. Drying procedures and gowning.

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--STERILE TECHNIQUE--

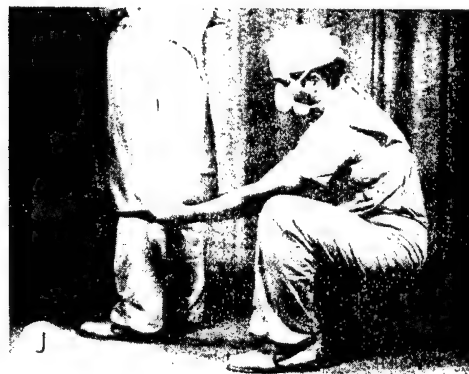
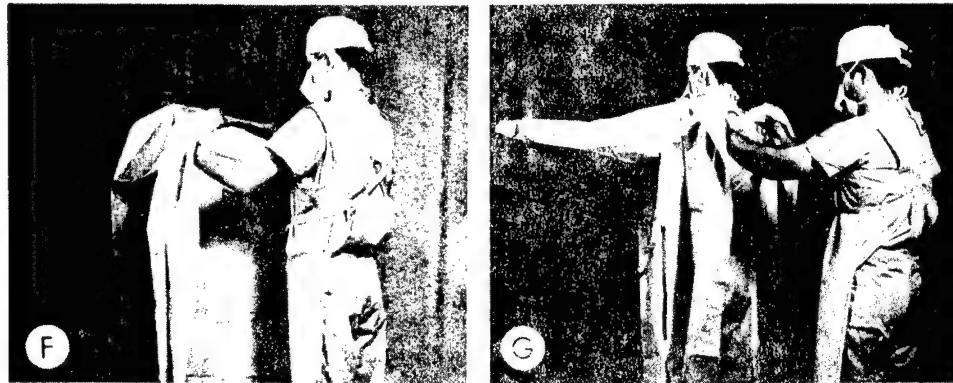


Figure 5. (Cont'd)

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Figure 6. Gloving--closed method.  
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--STERILE TECHNIQUE--



Figure 6. (Cont'd)



--STERILE TECHNIQUE--



Figure 7. Gloving--open method.

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Figure 7. (Cont'd)

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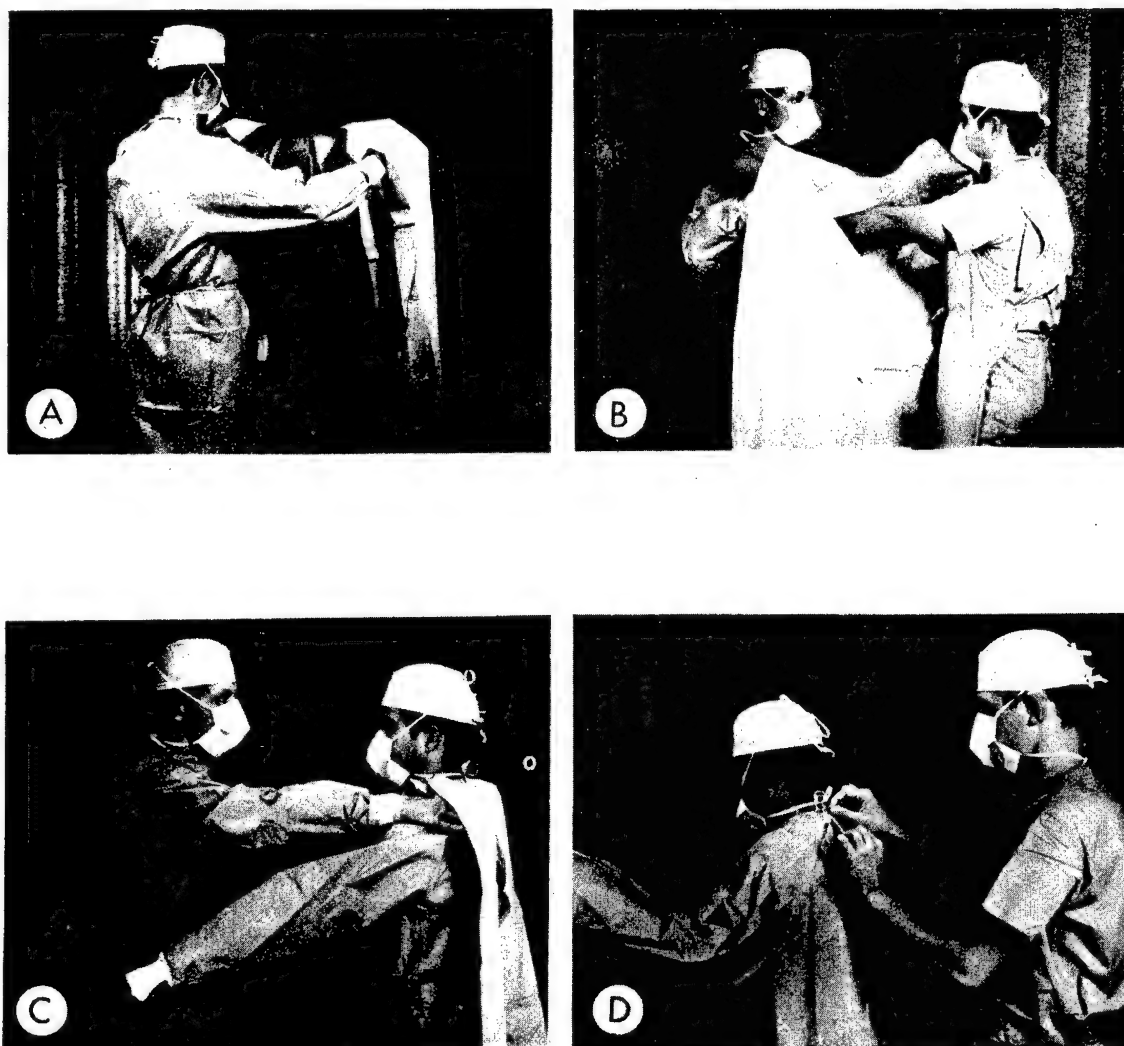


Figure 8. Assisted gowning and gloving.

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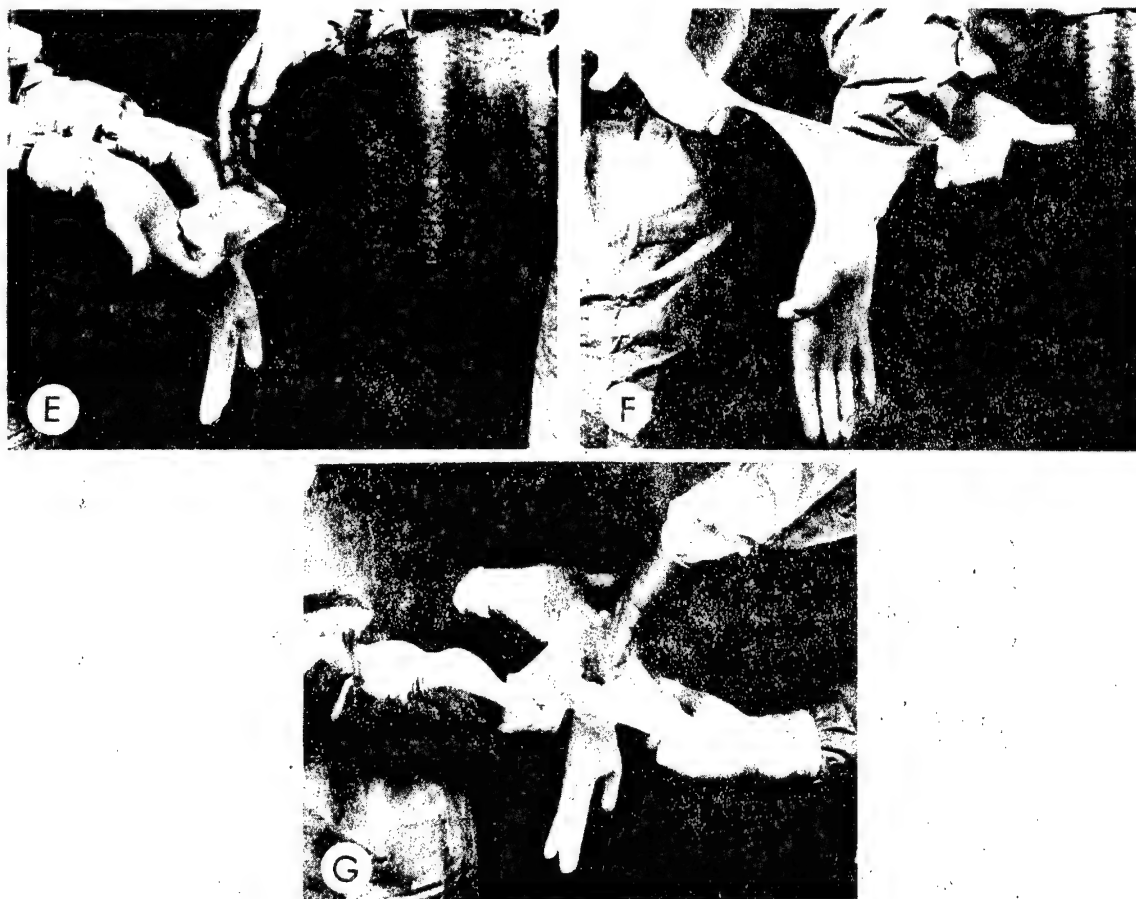


Figure 8. (Cont'd)

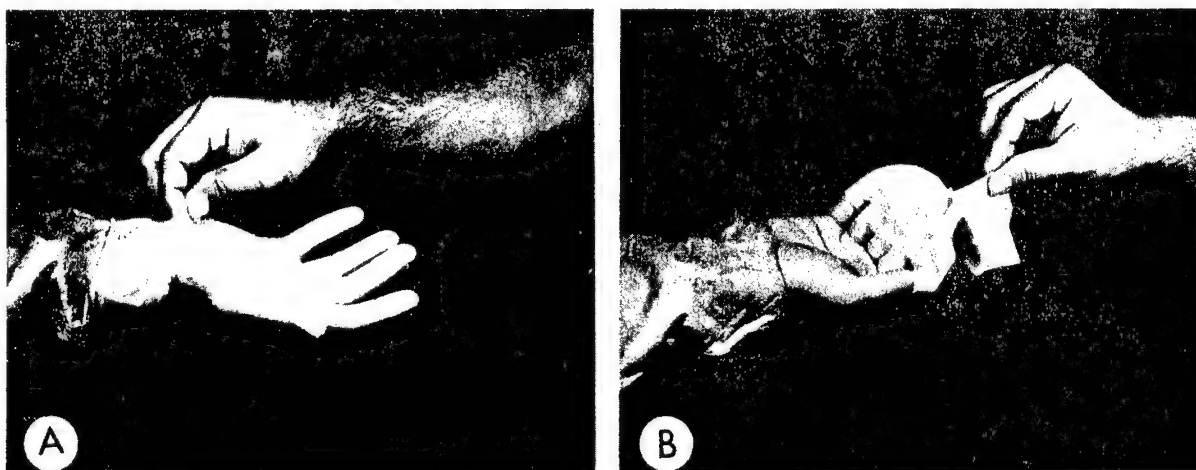


Figure 9. Removal of contaminated gloves.

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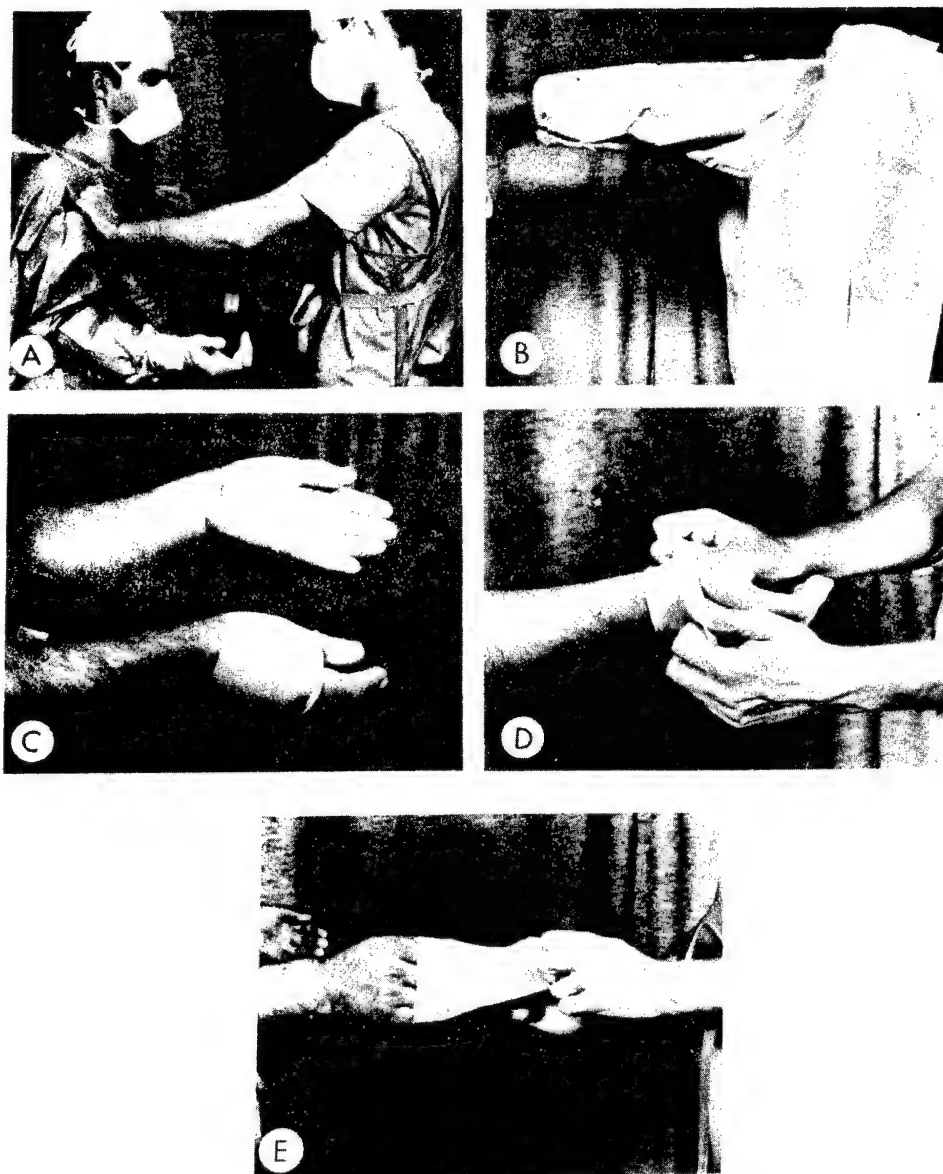


Figure 10. Removal of contaminated gown and gloves.

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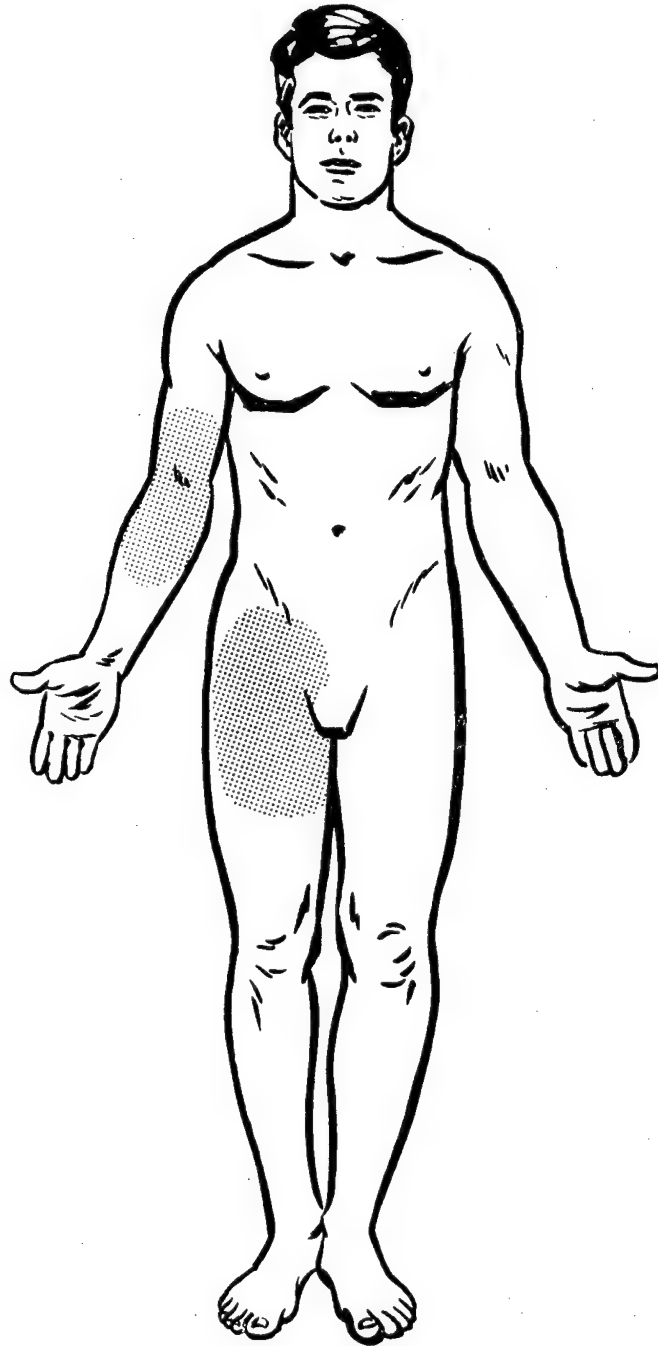


Figure 11. Operative sites to be shaved and prepped.



Figure 12. Patient draping, and draping of the right antecubital area.

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--STERILE TECHNIQUE--

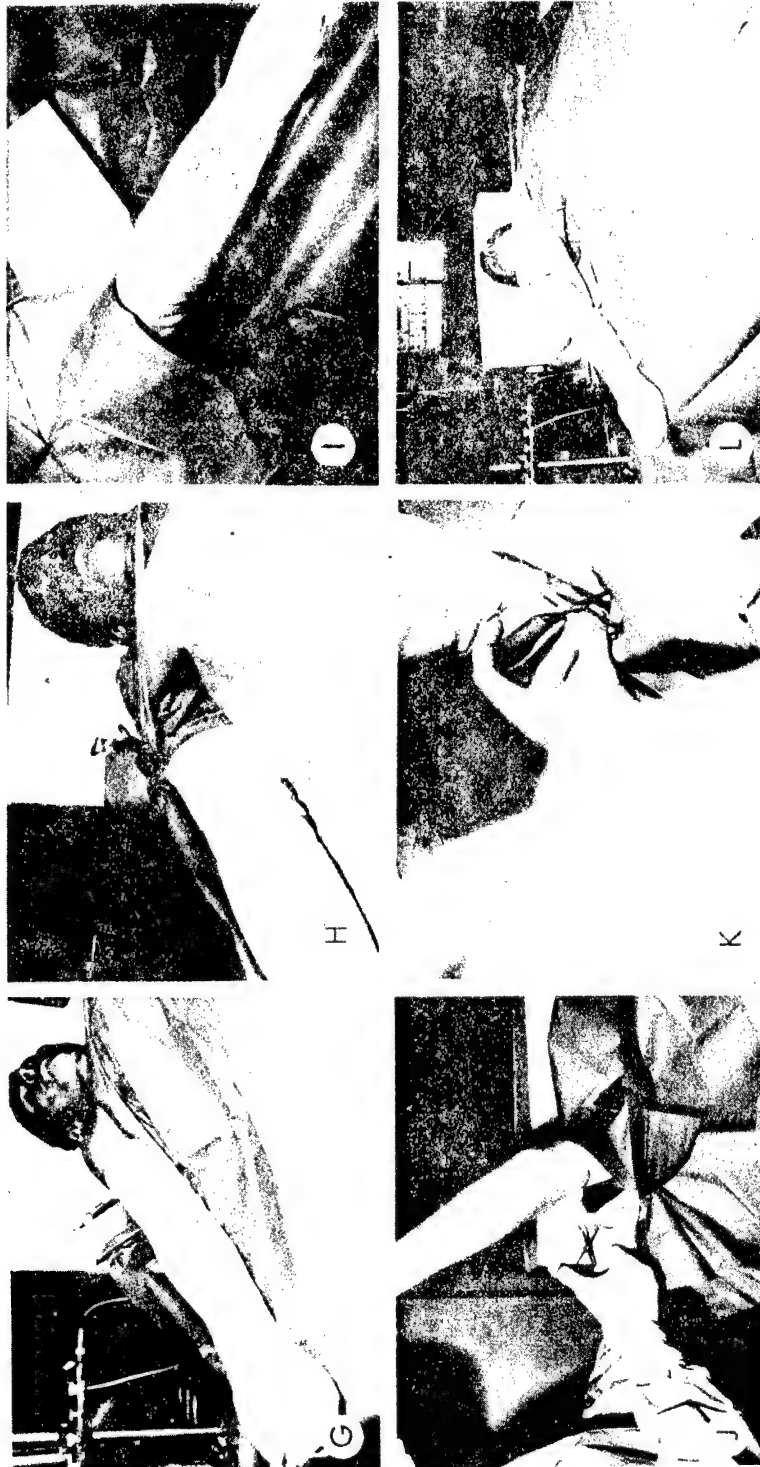


Figure 12. (cont'd)



--STERILE TECHNIQUE--



Figure 13. Draping of the right inguinal region.

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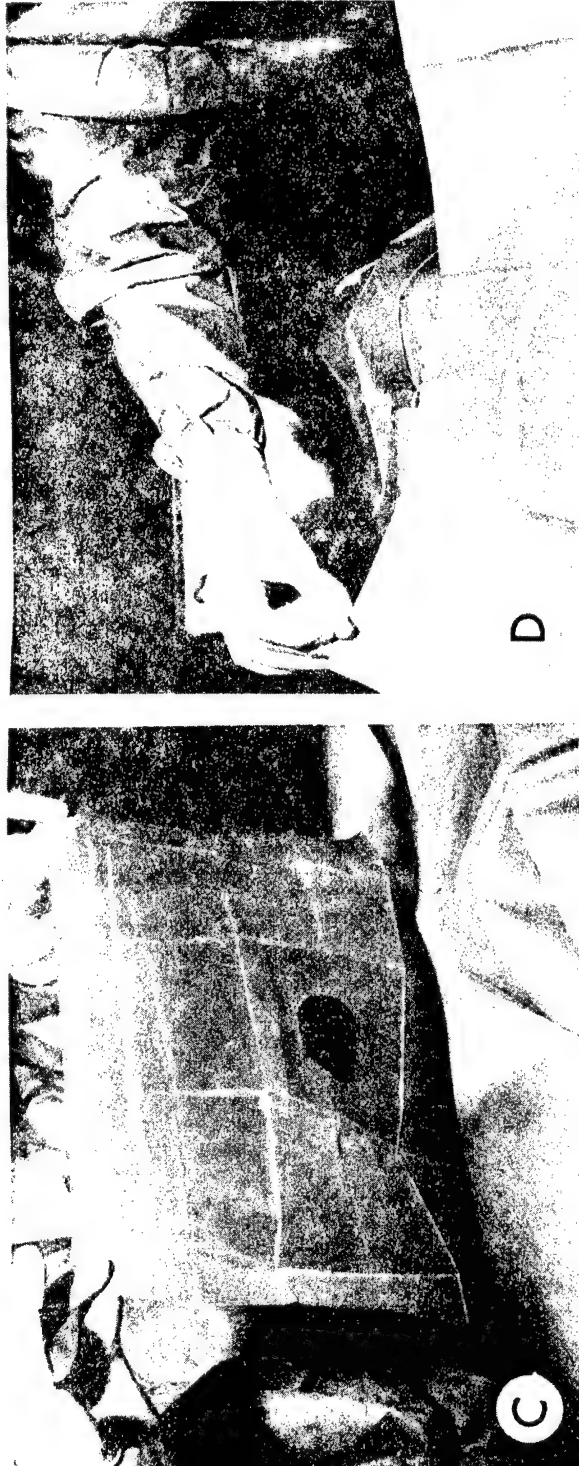


Figure 13. (Cont'd)

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--STERILE TECHNIQUE--



Figure 13. (Cont'd)

--STERILE TECHNIQUE--



Figure 14. Additions of sterile packaged articles to the sterile field.

--STERILE TECHNIQUE--



Figure 15. Unwrapping and addition of a larger sterile package to the sterile field.

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--STERILE TECHNIQUE--



Figure 15. (Cont'd)

--STERILE TECHNIQUE--

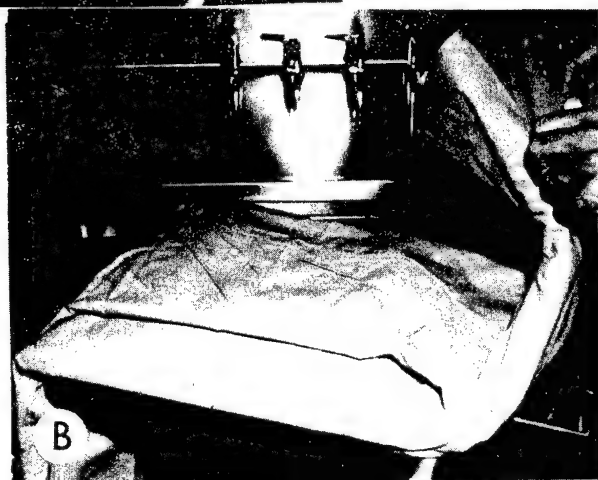
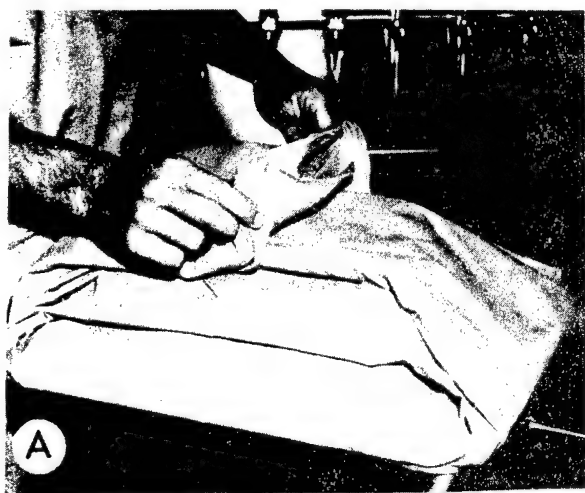


Figure 16. Unwrapping of a sterile tray.

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--STERILE TECHNIQUE--

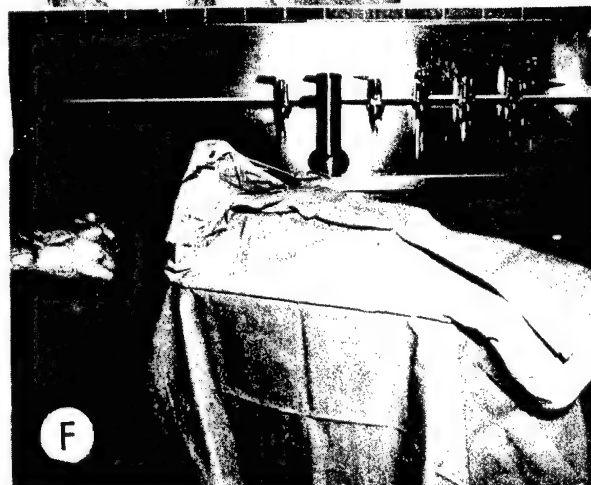
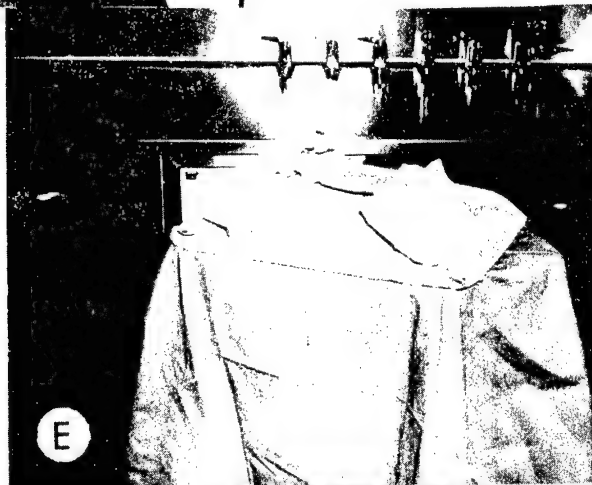


Figure 16. (Cont'd)

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--STERILE TECHNIQUE--

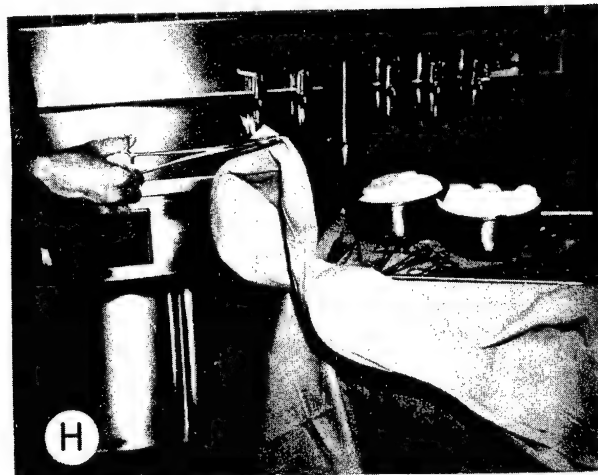


Figure 16. (Cont'd)

## ELECTRICAL AND RADIATION SAFETY IN THE CARDIOVASCULAR LABORATORY

### Electrical Safety

Since the protective covering of the body is violated during cardiac catheterization, there is the risk of "micro shock" to the heart--resulting in ventricular fibrillation and death (7). The risk is potentiated by the fact that "leakage currents" are quite common in most electrical equipment (2). Several methods have been devised to protect the cardiac catheterization patient from these currents:

First, a good quality grounding system is required. Second, an adequate electrical isolation system is necessary in all equipment. Third, all electrical equipment should be frequently monitored for leakage currents (6). The ultimate answer, however, lies in safety features incorporated in equipment design and manufacture.

A monthly safety check of electrical equipment is made by the bioelectrical engineer or his representative (Table 2), and the results are recorded on Form No. 4. (The duties of the electronic technician are described in the report section on: "Personnel and Responsibilities.") All findings are reported to the physician in charge of the laboratory. Not only must the equipment checklist be completed, but the following items must be evaluated:

- a. Three-prong plugs and receptacles are required on every piece of line-powered equipment. (Two-prong "cheaters" are not allowed in the laboratory.)
- b. All wiring in the laboratory wall sockets and cords is visually checked.
- c. Extension cords are not permitted.
- d. The resistance of all power cords is checked to assure continuity of each of the three wires.
- e. Conductive flooring, if present, is checked every three months.
- f. The energy outputs of the defibrillator are checked; and monthly conductivity tests--combined with semiannual x-rays of all defibrillator paddles, cables, and connector assemblies--are also accomplished.

### Radiation Safety

The radiation dose to the patient, and concomitant dose to personnel via radiographic procedures, is greater in the cardiovascular laboratory because of the high milliamperage requirements of cine-fluorography (3). Moreover, image intensifiers with automatic brightness control may experience a rise in x-ray tube current and potential--unknown to the user--thus causing an increased patient exposure (5).

Exposure to all involved can be mitigated by conscientious and deliberate reduction of fluoro- and cine-time. However, it is important

--ELECTRICAL AND RADIATION SAFETY--

to measure the tabletop exposure rate at regular periods to ascertain changes in the unit's peak kilovoltage (kVp) and milliamperage (ma); corrective action is taken if necessary.

The tabletop exposure rate is measured with a standardized aluminum phantom in the useful beam, and a record of these measurements retained for future reference and comparison (5). Scatter radiation measurements can be taken with a 22-cm phantom composed of Prestwood or water.

For control of excessive radiation exposure, one useful technique (which rarely receives the attention it should) is to use as small a radiation beam as possible to derive satisfactory diagnostic information. This beam size is accomplished by proper beam collimation via collimators, adjustable diaphragms, or shutters which are an inherent part of the x-ray tube assembly. A properly restricted beam is manifested as an unilluminated peripheral margin on the T.V. monitor. Scatter radiation can be much greater when the shutters are open wide than when the beam is coned-down.

Reduction of patient skin and gonadal dose is afforded by use of a lead absorber (lead apron or sheet), placed on the tabletop between the patient and the undertable x-ray tube target. The radiation absorber should be located at waist level. Fluoroscopic tables with wooden cradles decrease patient exposure by virtue of increased distance from the x-ray tube; however, scatter is increased.

Previous studies have confirmed that the physician performing the catheterization receives the highest exposure at chest level (1,4,8). Several fundamental preventive measures and precautions can be taken by medical personnel to control their radiation exposure:

- a. Wear a protective apron of at least 0.25 mm lead equivalent. The apron should be hung, unfolded, when not used. Old aprons should be checked for cracks by taking x-ray pictures of them.
- b. Keep hands out of the x-ray beam.
- c. Wear two x-ray dosimeters--one on the collar (to measure eye exposure); and the other under the lead apron, between the waist and shoulders (to measure whole body and skin exposure). These dosimeters should be provided and evaluated by a reputable organization with facilities for calibrating x-ray film.

Personnel radiation exposure records provided by the dosimeter vendor are filed for future reference, and current records maintained. Unusual results are promptly investigated and the cause documented. A signed statement from the individual involved, acknowledging the documentation, is obtained for reference in case legal complications arise.

--ELECTRICAL AND RADIATION SAFETY--

Scatter radiation from fluoroscopic tables with wooden patient cradles will vary, depending upon the position of the cradle. For example, when the patient cradle is mechanically rotated, with the patient's right arm elevated (right anterior oblique position), the chest-level radiation exposure to the physician is significantly increased.

The following precautions will help to reduce radiation exposure:

- a. Rotate personnel--especially the senior physician.
- b. Remain as far as possible from the fluoroscopic table whenever permissible, without compromising the patient's health.
- c. Be sure that the location of the cardiac monitoring equipment and operator is relatively distant from the fluoroscopic table and use a portable shield.
- d. Use videotape recording to obviate repeat examinations, thus avoiding additional irradiation of all involved.

As a general precaution, one should keep informed on current State and Federal radiation control regulations to assure compliance. This additional action, plus implementation of the foregoing preventive measures, will ultimately assure a successful radiation protection program in the cardiac catheterization laboratory.



--ELECTRICAL AND RADIATION SAFETY--

TABLE 2. PERIODIC EQUIPMENT SAFETY CHECKS

A. Medical Maintenance Representative will perform the following safety checks on equipment/location on a monthly basis--

Check ground, leakage, and potential difference for all equipment, by use of a Bio-optronics microammeter model ESD-101. This will include breakage of ground. Limits of acceptability will be:

1. Ground attached - no leakage
2. Ground broken - 100 ma

B. Output of all defibrillators involved will be measured every 6 months, and a scale of actual output posted on each defibrillator.

C. All equipment will be tagged (e.g., according to AFTO Form 27) to indicate acceptability.

D. The ground alarm system in the Cardiac Catheterization Laboratory will be checked weekly.

E. At least one receptacle outside door of the operating room used will be checked for leakage, and tagged semi-annually.

F. Applicable regulations/manuals are:

AFP 160-3	Prevention of Electrical Shock Hazards in Hospitals <u>(a)</u>
NFPA 56-A	Inhalation Anesthetics (1973) <u>(b)</u>
56-F	Non-flammable Medical Gases (1973) <u>(b)</u>
76-A	Electrical Systems for Hospitals (1973) <u>(b)</u>
76-BM	Safe Use of Electricity in Hospitals (1971) <u>(b)</u>
76-CM	Safety on High Frequency Electrical Equipment (1971) <u>(b)</u>
AFMMFO	Bulletins--OPR:AF/SCHLP (prepared by AFMMFO/FOE) <u>(c)</u>
AFM 167-1	Preventive Maintenance Procedures and Serviceability Standards for Medical Equipment <u>(a)</u>
AFM 67-1	Vol. V Ch. 21: Medical Equipment Maintenance and Repair <u>(a)</u>

NOTE: Do not change, modify, alter, or remove, etc., any extension cords without checking with Medical Maintenance.

(a) U.S. Government Printing Office, Washington, D.C. 20402.

(b) National Fire Protection Assoc., Int'l., 60 Batterymarch St., Boston, Mass. 02110.

(c) Air Force Medical Materiel Field Office, Frederick, Md. 21701.

AFSC-AAFB-WASH., D.C. 1969

## TRAYS AND EQUIPMENT FOR THE CARDIOVASCULAR LABORATORY

Illustrated in Figures 17 - 26 are the equipment and trays which are useful in the preparation for and the performance of cardiovascular catheterization procedures. The Basic Cardiac Catheterization Tray is utilized in most of the routine procedures. Additions to this tray permit the performance of any procedure utilizing the technique of choice (i.e., percutaneous procedure additions). A Cutdown Tray has also been described for those situations not requiring the Basic Tray (i.e., His bundle electrocardiography, transvenous pacing, etc.).

For each of these photographs (Figs. 16 - 26), a key is provided so that the items within the respective illustration can be readily identified.



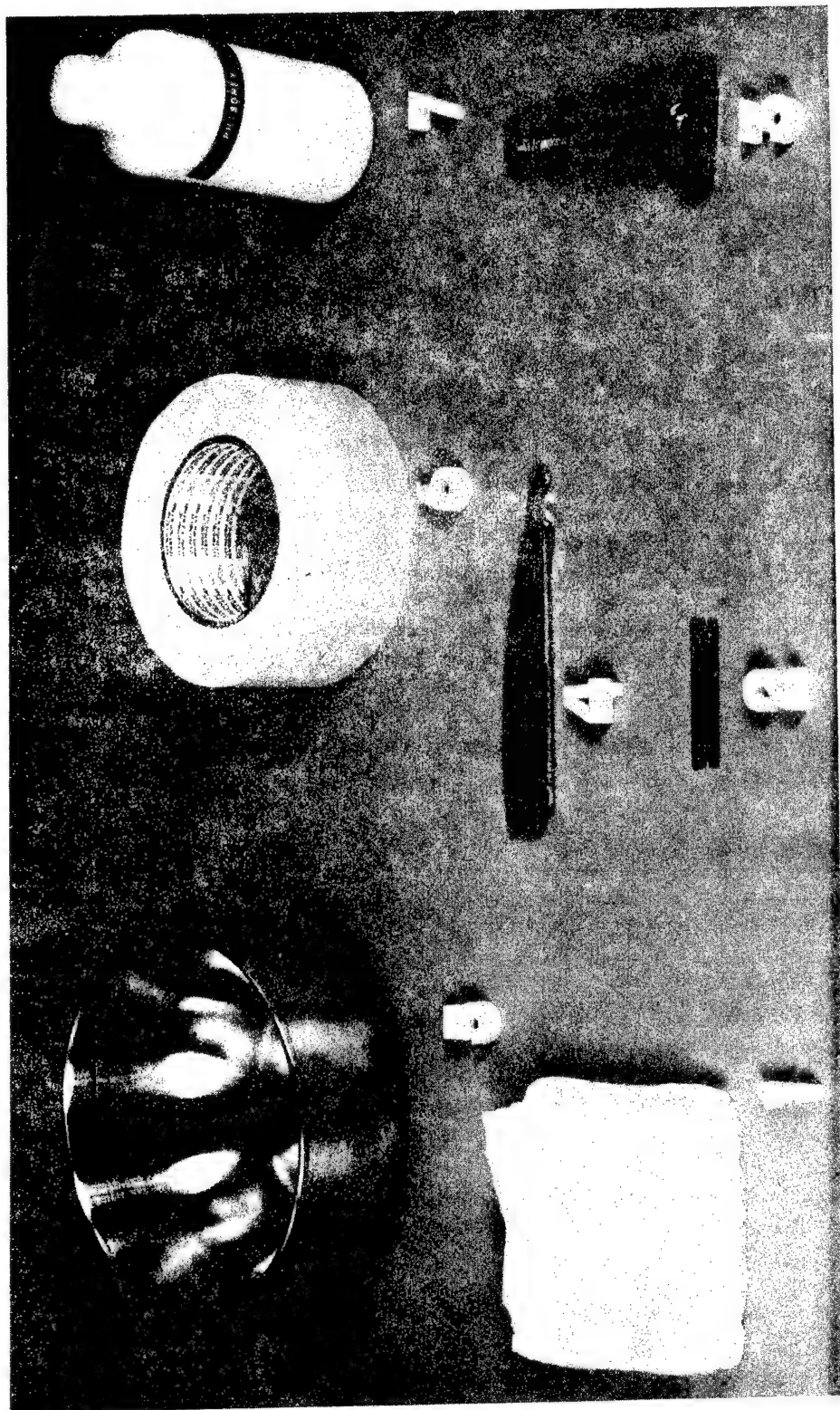


Figure 17. Shaving equipment.

- (1) Sponges: 4 x 4 in.--30.
- (2) Blade: Straight-edge razor.
- (3) Safety razor.
- (4) Straight-edge razor handle with blade guard.
- (5) Sponge basin.
- (6) Masking tape (very useful in removing loose hair).
- (7) phisoHex.



Figure 18. Surgical preparation equipment.

- (1) Normal saline in pour-type bottle.
- (2) Aqueous Zephiran solution (1:750).
- (3) pHisoHex.
- (4) Sterile prep-set (two solution cups and gauze-pad-holding forceps).
- (5) Sponges: 4 x 4 in.
- (6) Surgical gloves.

--TRAYS AND EQUIPMENT--

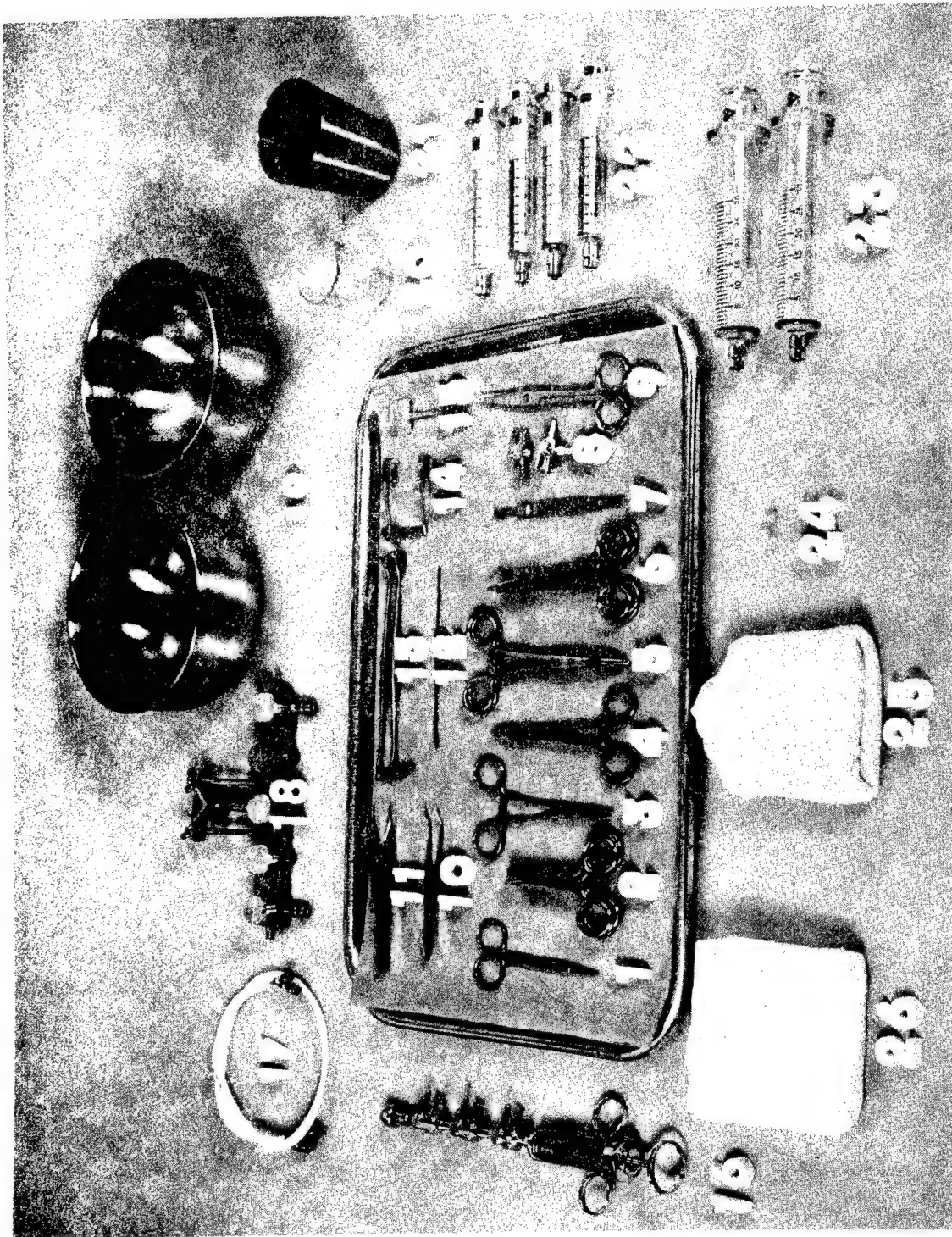


Figure 19. The Basic Cardiac Catheterization Tray. (For key, consult facing page.)

--TRAYS AND EQUIPMENT--

-- Key to Figure 19 --

1. Iris scissors
2. Towel forceps (clips)---6
3. Brown needle-holder (skin)
4. Webster needle-holder (artery)
5. Kelly hemostat, 5½ in.
6. Curved Halsted mosquito hemostats and straight Halsted mosquito hemostats---3 of each
7. Surgical knife handle
8. Stopcocks: one-way and three-way
9. General surgical scissors
10. Eye utility forceps
11. Adson tissue forceps
12. General operating probe
13. Senn's right-angle retractor---2
14. Wiener eye speculum
15. Hohn vessel dilator (catheter introducer)
16. Socorex syringe, 10 cc, and 3-way manifold with Teflon cores and rotating hub
17. High-pressure male-female connectors---2
18. Paley manifold, 5 Teflon cores
19. Sponge bowls
20. Medicine glass
21. Solution cup
22. Luer-Lok syringes, 10 cc---4
23. Luer-Lok syringes, 30 cc---2
24. Rubber sleeves, 1 cm long x 2 mm diam.---2
25. Stockinette: 4 in.
26. Sponges: 4 x 4 in.

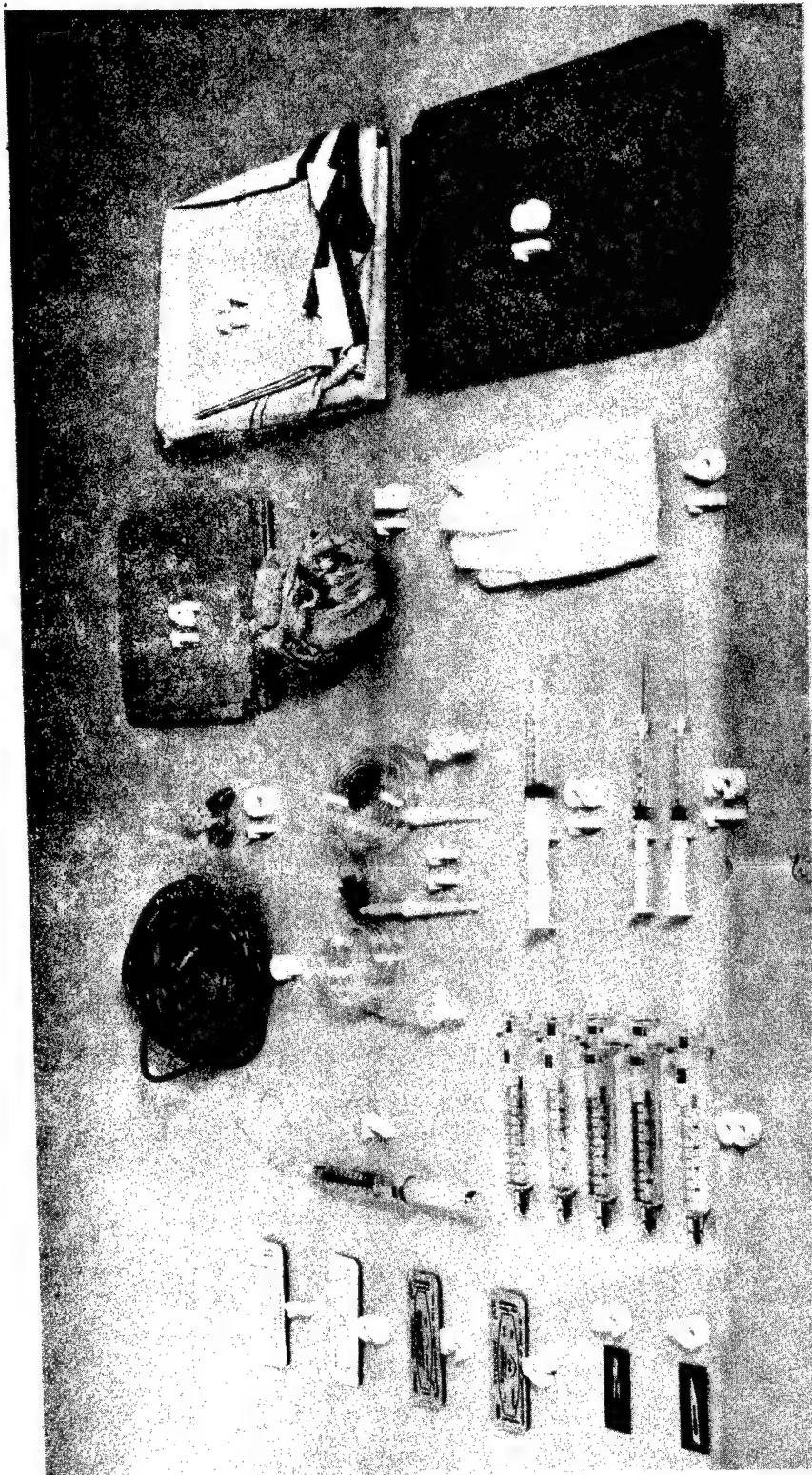


Figure 20. Additions to the Basic Cardiac Catheterization Tray.

(For key, consult facing page.)

--TRAYS AND EQUIPMENT--

--Key to Figure 20--

1. Umbilical ligature: 1/8 in. x 19 in. strand (cut to desired lengths)
2. Silk braided strands (4-0): 30 in. long (cut to desired lengths)
3. Prolene blue monofilament (6-0): double-armed C-1 tapered needles
4. Nylon black monofilament (4-0): FS-2 cutting needle
5. Blade, #15
6. Blade, #11
7. Luer-Lok syringe (10 cc), with medium intracatheter
8. Luer-Lok syringes---5
9. Pressure transducer
10. Pressure dome and hub for transducer
11. Sterile I.V. tubing sets---2
12. Disposable syringe (10 cc)---Lidocaine
13. Disposable syringe (2½ cc) with 18 Ga x 1½ in. needles---atropine
14. Nonabsorbent drapes---2
15. Nurse's surgical hat (cine drape)
16. Surgeon's gloves
17. Sterile surgical gown and hand towel
18. Sterile sheet for surgical drape



--TRAYS AND EQUIPMENT--

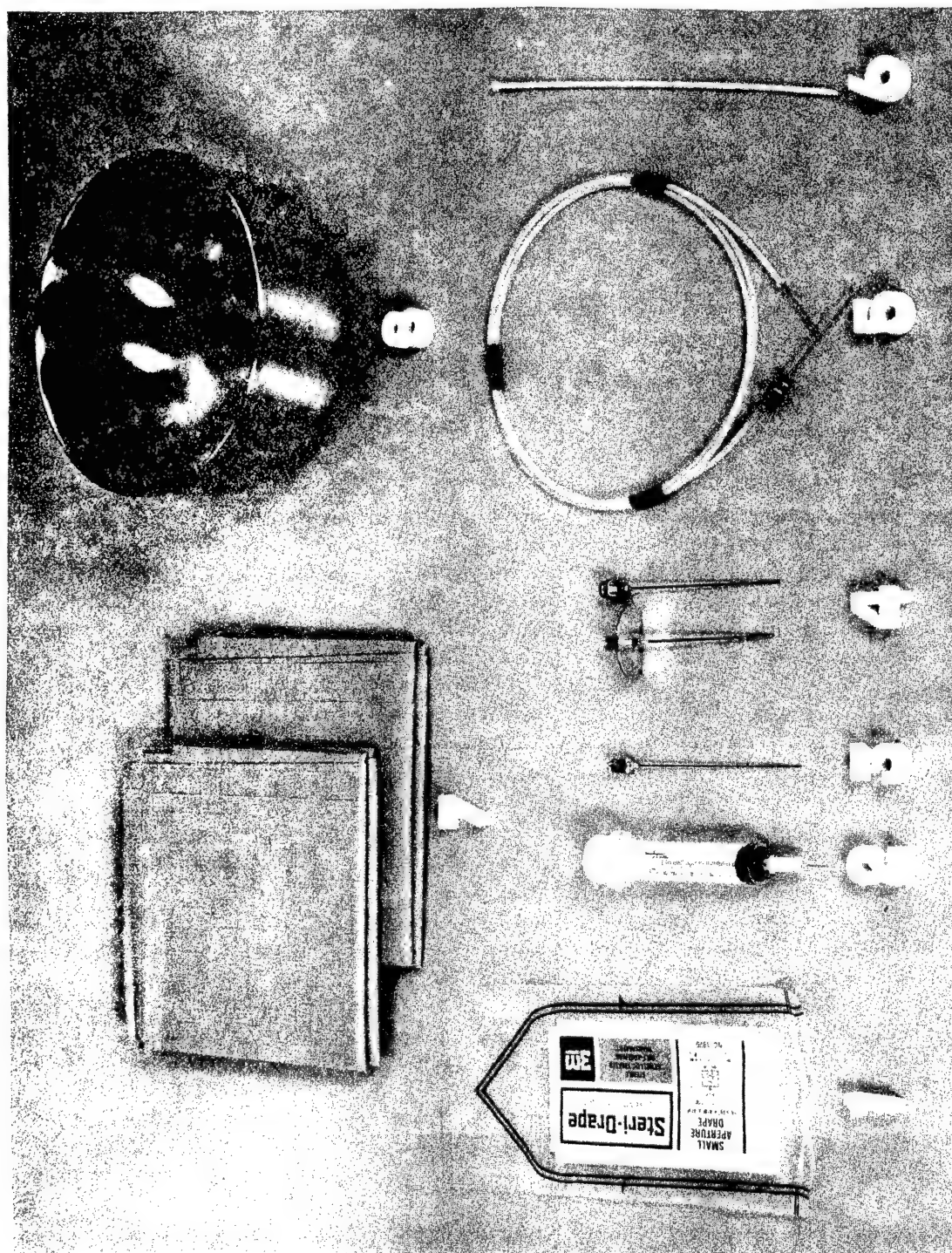


Figure 21. Percutaneous procedure additions to the Basic Cardiac Catheterization Tray. (For key, consult facing page.)

--Key to Figure 21--

1. Small aperture drape with adhesive back
2. Disposable syringe, 10 cc, with 26 Ga needle (local anesthesia)
3. Needle (deep local anesthesia): 23 Ga x 3½ in.
4. Courmand needle with stylet
5. Teflon-coated guidewire (0.038) in guidewire holder---1 to 3
6. Vessel dilator
7. Nonabsorbent drapes---4
8. Sponge bowl



--TRAYS AND EQUIPMENT--

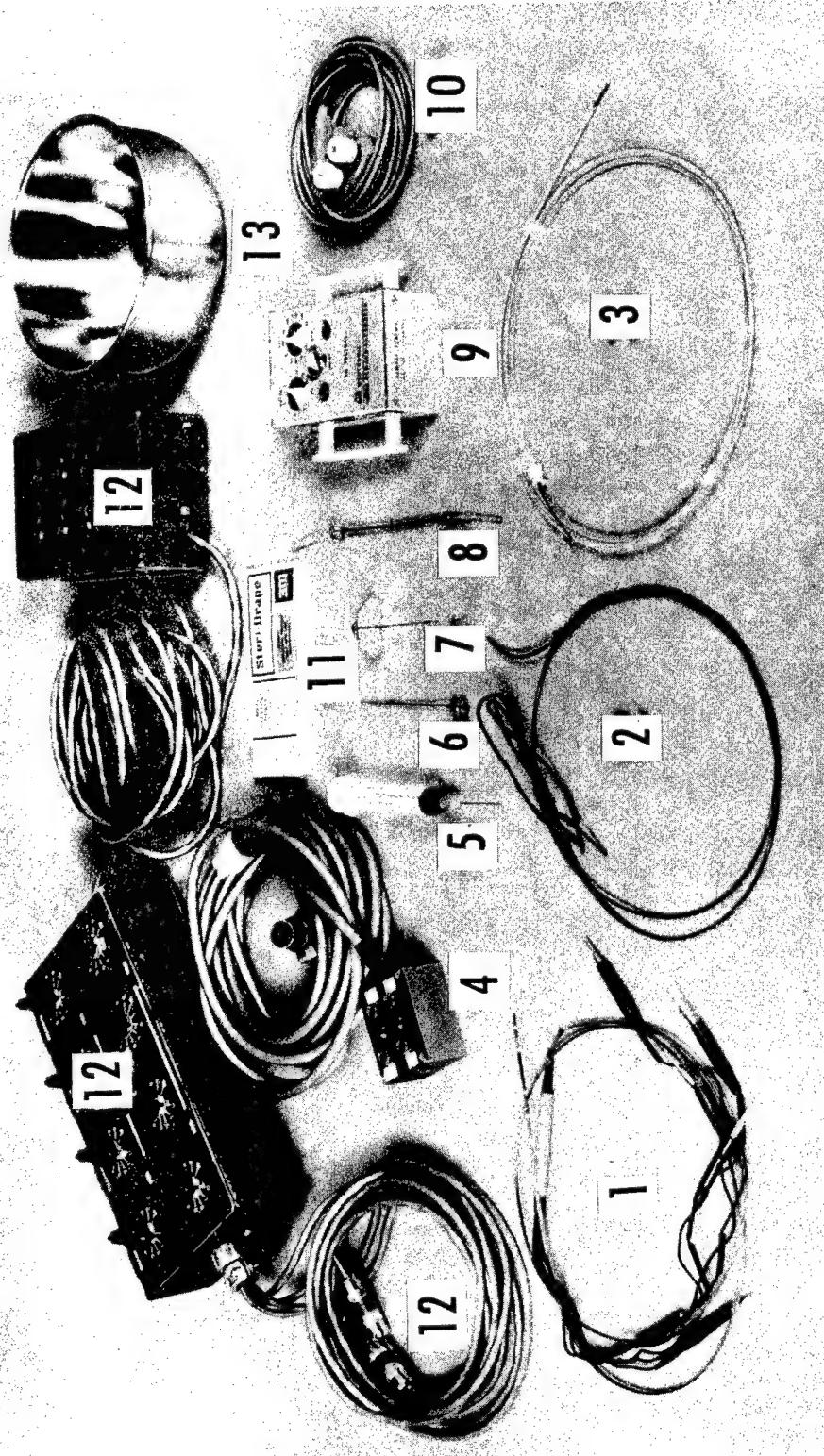


Figure 22. His bundle additions to the Basic (or Cutdown) Tray. (For key, consult facing page.)

--TRAYS AND EQUIPMENT--

-- Key to Figure 22 --

1. Quadrapolar catheter, 7F x 100 cm
2. Tripolar catheter, 6F x 100 cm
3. Guidewire and holder, 0.035 x 125 cm
4. High right atrial junction box
5. Syringe, 10 cc, with 23 Ga x 3/4 in. needle
6. Needle (local anesthesia) 23 Ga x 2 1/4 in.
7. Courmand needle with stylet
8. Vessel dilator with mylar sheath (introducer)
9. Pacemaker (stimulator)
10. Pacemaker, cable
11. Small aperture drape, adhesive back
12. Junction box
13. Sponge basin

--TRAYS AND EQUIPMENT--

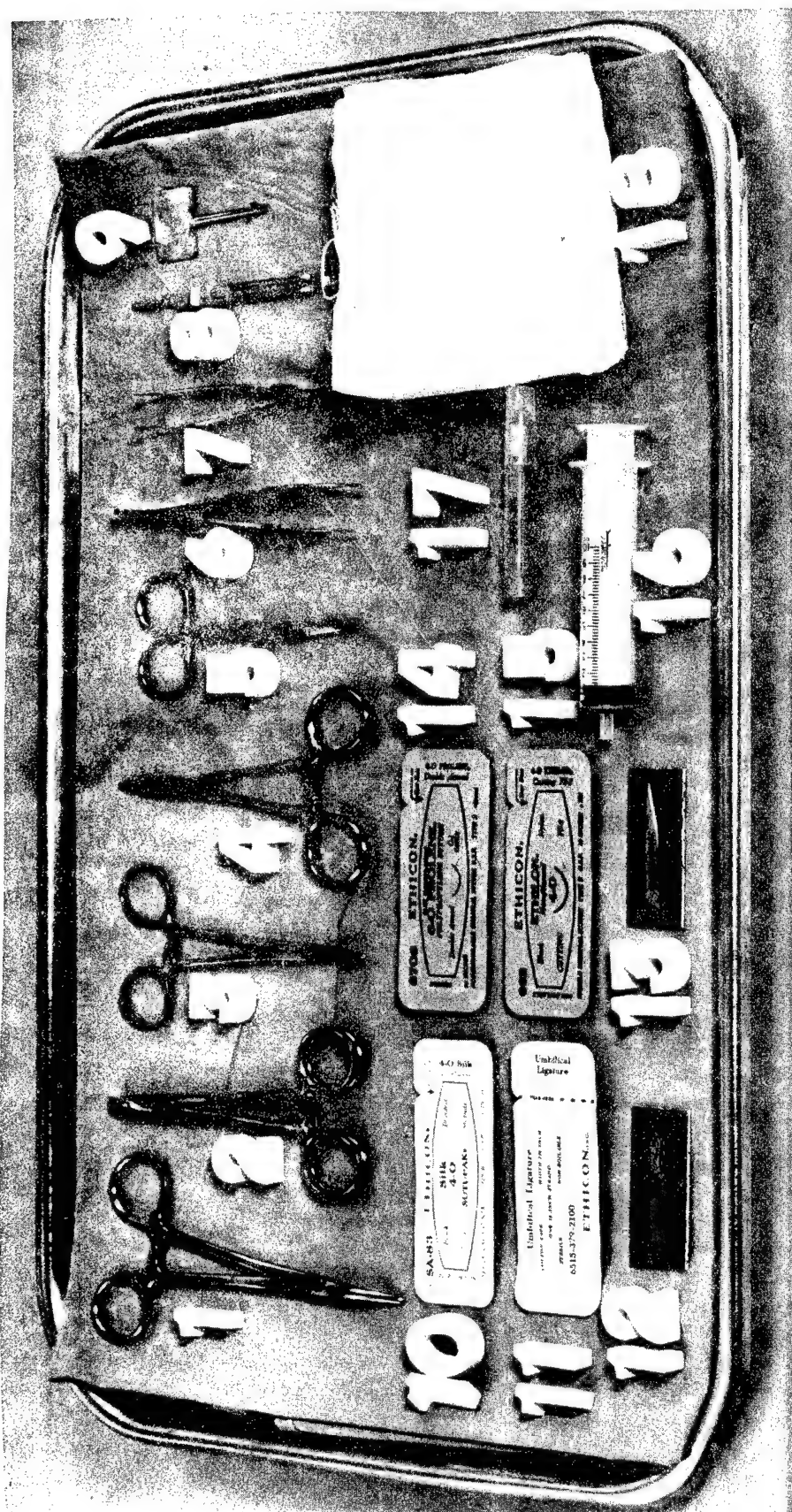


Figure 23. Cutdown Tray. (For key, consult facing page.)

--TRAYS AND EQUIPMENT--

-- Key to Figure 23 --

1. Kelly hemostat, 5½ in.
2. Curved Halsted mosquito hemostats---2
3. Webster needle-holder (artery)
4. Brown needle-holder (skin)
5. Iris scissors
6. Adson tissue forceps
7. Eye utility forceps
8. Surgical knife handle
9. Hohn vessel dilator (catheter introducer)
10. Silk braided strands (4-0): 30 in. long
11. Umbilical ligature: 1/8 x 18 in. strand
12. Blade, #15
13. Blade, #11
14. Prolene blue monofilament (6-0), double-armed with C-1 tapered needles
15. Nylon black monofilament (4-0), with FS-2 cutting needle
16. Disposable syringe, 10 cc
17. Needle: 23 Ga x 3/4 in.
18. Sponges: 4 x 4 in.

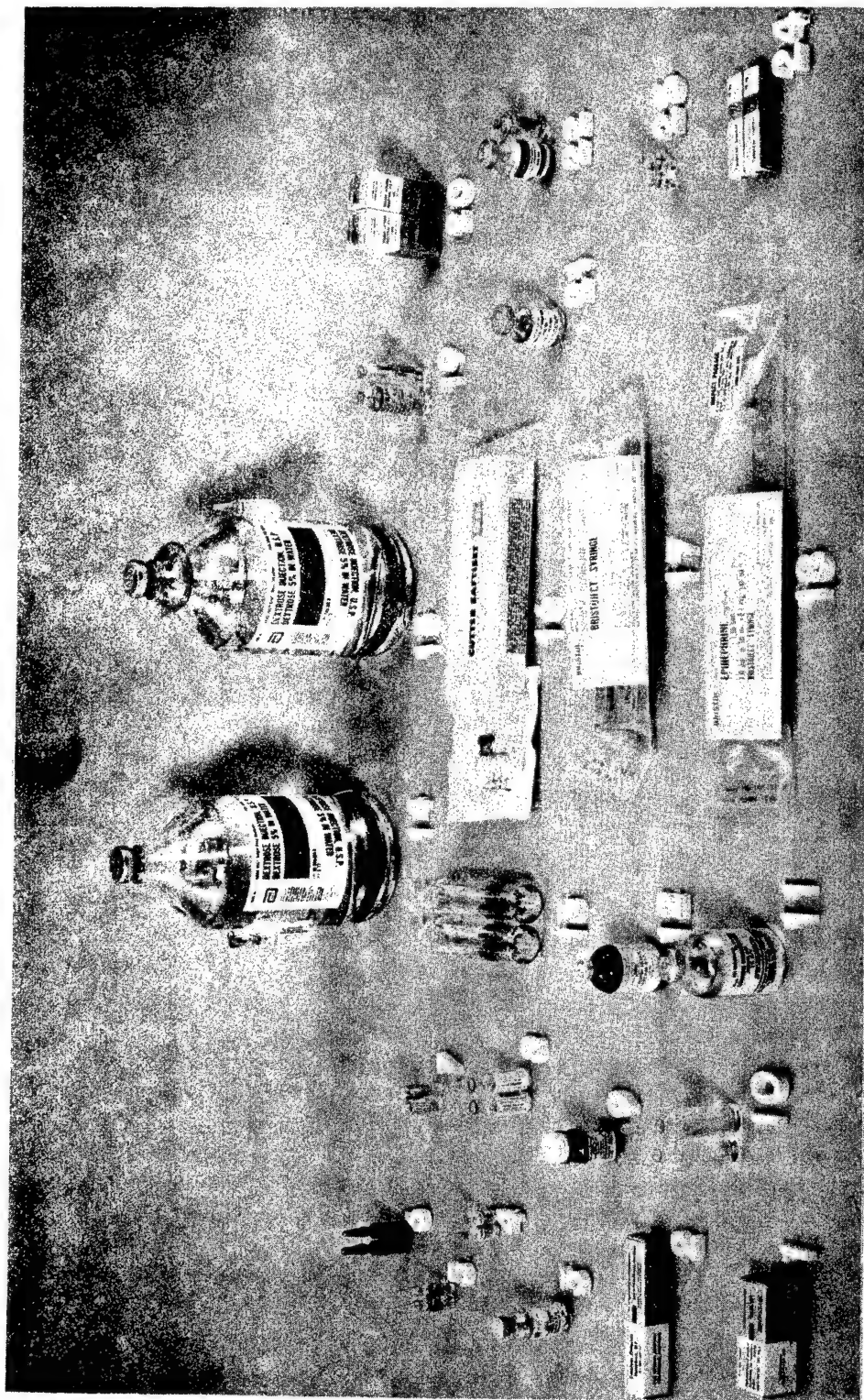


Figure 24. Emergency Drug Tray. (Key is below, and on facing page.)

1. Solu-Cortef mix-o-vial: 100 mg
2. Calcium chloride: 10 cc ampule, 100 mg/cc
3. Aramine: 10 cc vial, 10 mg/cc

--TRAYS AND EQUIPMENT--

-- Key to Figure 24 (cont'd.) --

4. Tensilon: 1 cc ampule (10 mg)
5. Epinephrine injection: 1 cc ampule, 1:1000
6. Lasix: 2 cc ampule, 10 mg/cc
7. Digoxin (Lanoxin): 2 cc ampule, 0.25 mg/cc
8. Levophed: 4 cc ampule, 2 mg/cc
9. Sublingual nitroglycerin tablets: Gr 1/150
10. Aminophylline: 10 cc ampule, 25 mg/cc
11. Lidocaine HCl: 50 cc vial, 1%
12. Atropine: 20 cc vial, 0.4 mg/cc
13. Sodium bicarbonate injection: 50 cc ampule, 44.6 meq
14. Dextrose injection: 1000 cc, 5%, with attached Levophed (2 ampules), alcohol sponge, and intravenous injection set
15. Dextrose injection: 1000 cc, 5%, with attached Isuprel HCl (2 ampules), 1.2 mg/cc, alcohol sponge, and intravenous injection set
16. Intravenous set with three-way stopcock
17. Sodium bicarbonate: 50 cc, 44.6 meq
18. Epinephrine: 10 cc, 1:10,000
19. Potassium chloride: 10 cc ampule, 2 µg/cc
20. Heparin injection: 10 cc vial, 1000 mg/cc
21. Atarax: 100 vial, 50 mg/cc
22. Dilantin with diluent: 100 mg
23. Benadryl: 1 cc ampule, 50 mg/cc
24. Compazine: 2 cc ampule, 5 mg/cc



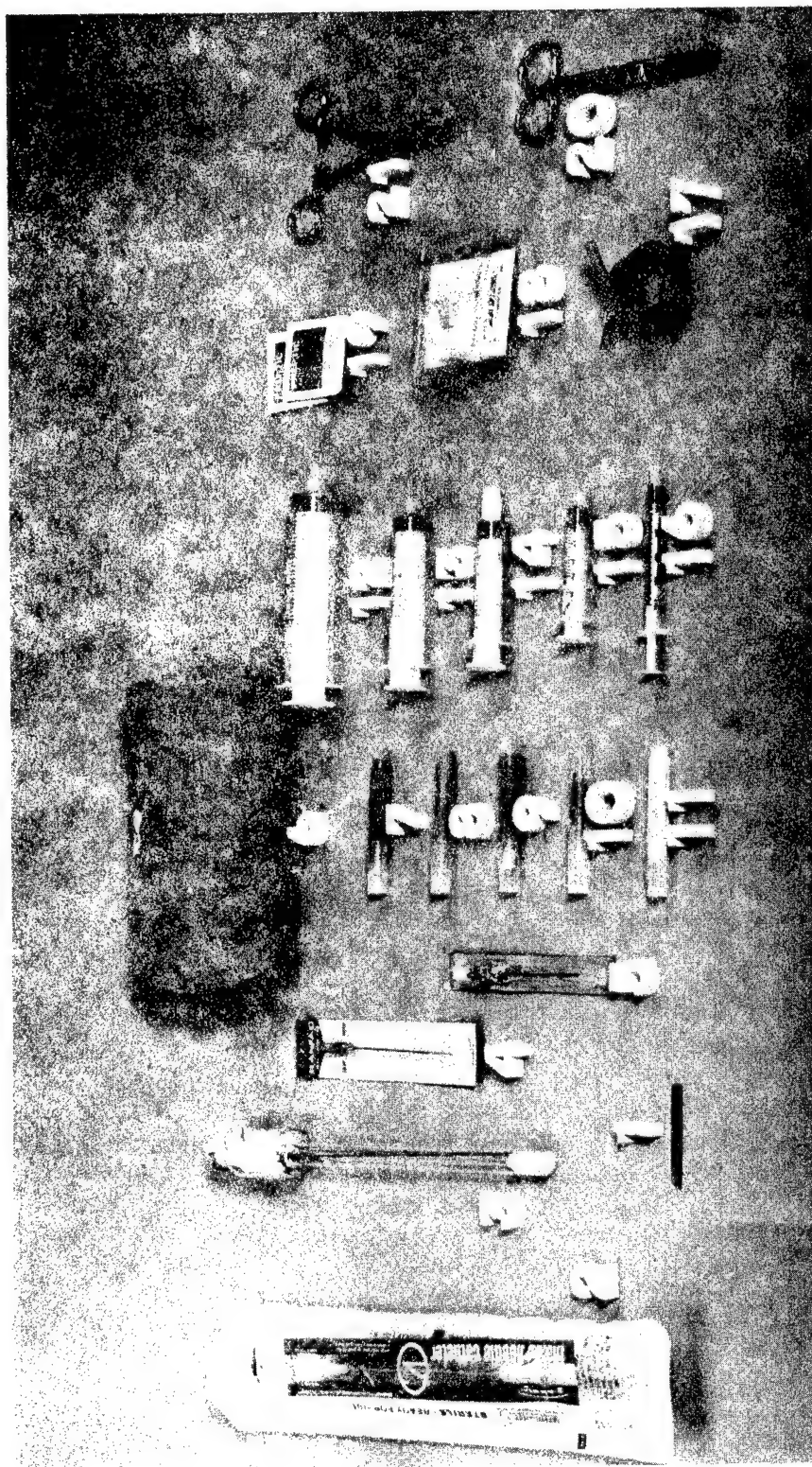


Figure 25. Additional emergency supplies. (For key, consult facing page.)

--TRAYS AND EQUIPMENT--

-- Key to Figure 25 --

1. Ampule file
2. Intracatheter, large
3. Cardiac needle: 6-in. #18
4. Cardiac needle: 3-in. #18
5. Intravenous catheter, Jelco: 2-in. #18
6. Syringe: 50 cc sterile glass syringe
- 7-11. Needles: #18, #20, #21, #23, and #26
- 12-16. Syringes (tuberculin): 30 cc, 10 cc, 5 cc, 2.5 cc
17. Tourniquet
18. Intravenous injection sets
19. Alcohol sponges
20. Straight scissors
21. Clamp with rubber tip



--TRAYS AND EQUIPMENT--

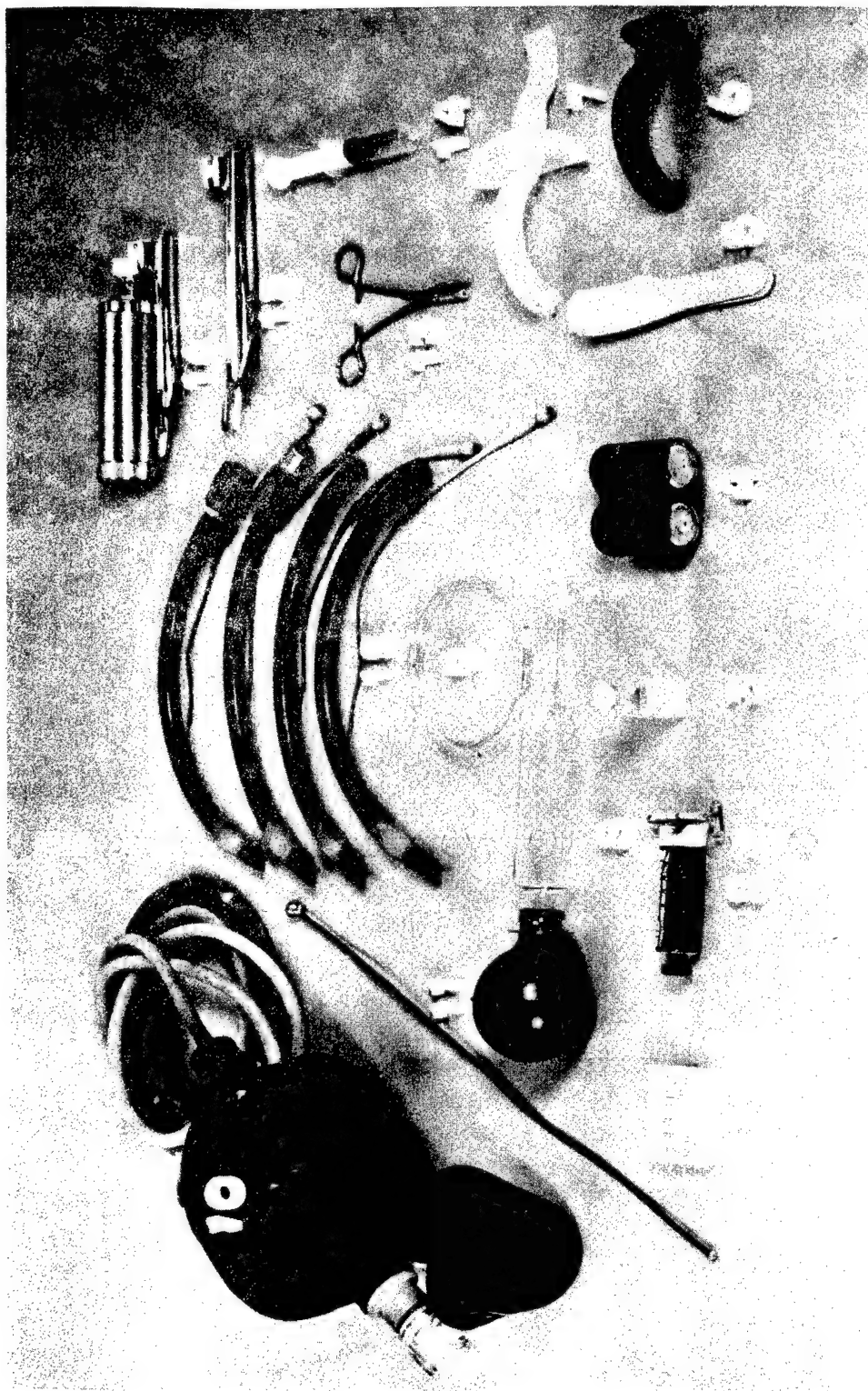


Figure 26. Intubation Tray. (For key, consult facing page.)

-- Key to Figure 26 --

1. Extra laryngoscope bulbs
2. Lidocaine jelly
3. Anectine: 20 mg/cc
4. Extra batteries for laryngoscope
5. Taped tongue blades
6. Pharyngeal airway (rubber): for adult
7. Pharyngeal airway (plastic): for child and adult
8. Glass bulb syringe
9. Levine tube
10. Ambu resuscitator with mask and oxygen hose
11. Endotracheal tube stylet
12. Endotracheal tubes: 30 Fr, 38 Fr, 40 Fr, and 42 Fr, with and without adapters
13. Straight mosquito hemostats with rubber-coated jaws
14. Disposable syringe, 10 cc
15. Extra laryngoscope blade
16. Laryngoscope with blade attached

## EQUIPMENT AND CATHETER CARE

### Equipment Care

Requirements may vary between manufacturers, and should be followed closely when specific recommendations are made. An acceptable program of instrument and equipment care and sterilization is outlined here (a - h):

- a. All instruments and equipment are rinsed and soaked in cold water as soon as possible after procedure.
- b. Equipment is then transferred to Central Supply area in a basin of cold water.
- c. Equipment is washed and flushed with a detergent solution until thoroughly clean.
- d. The equipment and supplies are then rinsed and flushed first with tap water, and then with distilled water.
- e. Equipment and supplies are then covered with clean towels and allowed to air-dry overnight.
- f. All equipment and supplies are wrapped and appropriately sterilized (i.e., steam autoclave, gas sterilize). Equipment sealed in plastic wrap for sterilization is considered sterile for 90 days; equipment sterilized in cloth wrappers is considered sterile for 30 days.
- g. Attest<sup>R</sup> biologic indicators are used with every gas-sterilization load. Spordi<sup>R</sup> biologic indicators are used once a month for both steam and gas sterilization controls. A log is kept of these results.
- h. The specifications for aeration times necessary for gas-sterilized supplies are provided by the manufacturers of the aeration cabinet.

### Catheter Care

The specific recommendations of the catheter manufacturers should be posted and followed carefully. An overview of a good catheter care program is presented in steps a - h:

- a. After removal from the patient, all catheters are immediately flushed with 50 cc of cold water, using a 20 cc syringe. In addition, the outside of catheters is wiped with a water-soaked sponge until clean. If the catheter does not flush clean with 50 cc of water, more is used. For catheters without an inner lumen (i.e., pacing catheter), the entire catheter is wiped clean with a damp sponge and soaked.
- b. Catheters are then soaked for 20 min in a solution of detergent, 1:750.
- c. After soaking, they are attached to a catheter flusher for 2 hr.
- d. The catheters are transferred to the central supply area in a basin of cold water.

--EQUIPMENT AND CATHETER CARE--

- e. After arrival in central supply, the catheters are rinsed and flushed with distilled water and allowed to dry on a clean wrapper.
- f. Before sterilization, the catheters are flushed with 100 cc of sterile water and air-dried (using a 20 cc syringe, until all water is removed).
- g. The formed-wire stylet or glass-forming molds are positioned in, or on, the distal catheter tip.
- h. The catheters are secured on catheter sterilization paper and wrapped in polyethylene tubing prior to gas sterilization using ethylene oxide. After sterilization, the catheters are placed in an aeration cabinet for 12 hr. Catheters thus prepared are considered sterile for 90 days.

## CATHETERS AND GUIDEWIRES

Of the different types of catheters and guidewires available for cardiac catheterization, the following are most frequently used in our Laboratory.

### Lehman Catheter

The Lehman is a thin-wall, end-hole catheter used primarily for right heart catheterization. The lumen is larger than that in a Cournand catheter of comparable size. The curve in the distal tip of the Lehman catheter is rounded. The catheter is constructed of woven Dacron with a radiopaque coating. The #7 and #8F, 100-cm-long catheters are most commonly used.

### Cournand Catheter

The Cournand is a standard end-hole, radiopaque catheter used for right heart catheterization, blood sampling, and wedge pressure data. The standard Cournand curve designed for right heart catheterization is incorporated in the distal tip, and retained with a tip stylet during storage. The sizes most commonly used are #7 and #8F, 100 cm long.

### Goodale-Lubin Catheter

The Goodale-Lubin catheter has the same basic woven Dacron construction as the Cournand, with the addition of 2 laterally opposed woven eyes close to the distal tip. The standard Cournand curve is formed on the distal tip and retained with a tip stylet. This catheter is used for obtaining blood samples and pressure data in the right heart and coronary sinus. The sizes most commonly used are #7 and #8F, 100 and 125 cm long.

### NIH Catheter

The NIH (National Institutes of Health) catheter has a thin-wall with a nylon core reinforced by woven Dacron. The distal tip is closed with 6 round eyes arranged in 3 laterally opposed pairs. This catheter is used primarily for angiographic studies of the aortic arch and left ventricle in the diagnosis of mitral and/or aortic insufficiency as well as aortic aneurysms. The sizes most commonly used are #7 and #8F, 100 cm long.

### Eppendorf Catheter

The Eppendorf catheter is constructed of woven Dacron and is designed to provide additional radiopacity with a minimum of lumen compromise. There is 20 cm of reinforced nylon sheath at the hub for additional support during pressure injections. The closed distal tip

## --CATHETERS AND GUIDEWIRES--

is completely radiopaque. The 6 openings are arranged in 3 laterally opposed pairs--similar to the NIH configuration except that the openings are oblong. The Eppendorf catheter is especially useful for angiocardiology and arteriography studies. The sizes most commonly used are #7 and #8F, 100 cm long.

### Gensini Catheter

The Gensini catheter is specifically designed for percutaneous introduction. It has a short tapered distal tip. There are 3 sets of laterally opposed side openings near the tip. The short tapered distal tip has a distal opening which is smaller than the lumen of the catheter to provide a close fit for the spring guide. It is most commonly used for left-sided angiography. The size most commonly used is #7F, 100 cm long.

### Sones Catheter

This is a woven Dacron catheter designed for selective catheterization of the coronary arteries. It is usually introduced intra-arterially directly, but may be used percutaneously with a 0.035 guidewire. Two types are available: Type I has a 1.5 in. tip, and Type II has a 1 in. tip. Although there is a #7F and #8F outer diameter size, both sizes have a 7F lumen tapering to a 5.5F tip. The #8F has a heavier wall, a more rigid shaft, and a greater radiopacity. Two laterally opposed side holes are positioned near the tip. A Sones "Positrol" 7.5F catheter has a fine stainless-steel mesh incorporated into the catheter wall for better torque control. The #7F and #8F, 80 and 100 cm lengths, are commonly used.

### Cordis Coronary Catheter

The Cordis femoral right and femoral left catheters are used for the selective catheterization of the coronary arteries. They have pre-formed coronary-seeking tip configurations. When properly positioned, the catheters will remain in place. These catheters have multiple curves, open ends, and no side holes. They use a 0.038 in. diam. guidewire. It is advisable to have the following sizes available:

#### Femoral left-formed catheter:

- #4F - 100 cm (for normal sized aortic root)
- #5F - 100 cm (for moderately dilated aortic root)
- #6F - 100 cm (for poststenotic dilatation)

#### Femoral right-formed catheter:

- #4F - 100 cm (for normal sized aortic root)
- #5F - 100 cm (for moderately dilated aortic root)
- #6F - 100 cm (for poststenotic dilatation)

## --CATHETERS AND GUIDEWIRES--

### Cordis Pigtail Catheter

The Cordis Pigtail has multiple curves and a tapered tip designed for percutaneous introduction over a 0.038 guidewire. The multiple side holes make it useful for left ventricular and aortic root angiograms. Its design also allows easy passage across most aortic valves. A #8F, 110 cm long, is most commonly used.

### Zucker Catheter

The Zucker multipurpose catheter is constructed of woven Dacron and has two platinum electrodes--one, at the distal tip; and another, 1.5 cm proximally. The lumen opens at the distal tip and through two lateral openings. (Zucker catheters, or other platinum electrode catheters, are available for use in determining shunts utilizing ascorbate or hydrogen ion.) In conjunction with these studies, blood sampling and pressure data can be obtained. This multipurpose catheter also provides a bipolar electrode for cardiac pacing. The size most commonly used is a #7F, 100 cm long.

### Hexapolar, Quadrapolar, Tripolar, and Bipolar Catheters

These catheters have platinum electrodes numbering from 2 to 6, and are used for intracardiac recording or pacing. They may be introduced into the vascular system by cutdown or percutaneously using a sheath introducer. The distal tip curve allows easy positioning for His bundle electrograms.

### Swan-Ganz Catheter

The Swan-Ganz is a balloon-tipped double lumen catheter. When inflated, the soft balloon at the tip allows the catheter to be propelled by the blood flow into the pulmonary artery. The soft balloon, which covers the catheter tip, also minimizes the occurrence of premature ventricular contractions during passage of the catheter through the right ventricle. Accurate wedge pressures can be obtained without catheter manipulation by inflating the balloon to occlude a pulmonary artery branch. These catheters have a preformed curvature at the balloon tip to facilitate passage through the right ventricle. The #5 and #7F, 110-cm-long catheters are most commonly used.

### Fogarty Catheter

The Fogarty arterial embolectomy catheter is a single lumen balloon catheter instrument designed specifically for embolectomy. The pliable body of the catheter was produced for ease of manipulation, with minimal trauma to the arterial system. The winged hub facilitates catheter manipulation and increases ease of syringe fixation. The sizes that should be available are: 4F, 40 cm long; 4F, 80 cm; 3F, 80 cm; 5F, 40 cm; and 5F, 80 cm.

## --CATHETERS AND GUIDEWIRES--

### Introducing Sheath (Mylar) and Introducing Catheter

In angiography, the use of closed-end catheters offers certain advantages compared to open-end tapered catheters. Until recently, there was no way to use closed-end catheters and the Seldinger technique for percutaneous introduction of a catheter. A new procedure has been described which permits the percutaneous insertion of closed-end catheters, thus combining the advantages of both methods.

This method uses a thin-wall Mylar sheath fabricated for a close fit over the catheter to be passed through it. The sheath is introduced into the vessel by the usual Seldinger procedure, except that the guidewire and introducing catheter are short. The Mylar sheath is passed over the introducing catheter and introduced into the vessel by advancing it with a slight twisting motion. The introducing catheter is then removed, and a closed-end catheter of the same size is passed through the sheath into the vessel.

The sheath is 10 cm long and has a wall thickness of 0.002 in. The color coding for size is:

Yellow	=	MYS-5 for #5F catheters
Red	=	MYS-6 for #6F catheters
Blue	=	MYS-7 for #7F catheters
White	=	MYS-8 for #8F catheters

The introducing catheter is a short length of radiopaque polyethylene tapered at one end to fit snugly over a guidewire. Color coding for size is:

Yellow-green	=	IC-5 #5F, 0.032 in. guidewire
Red	=	IC-6 #6F, 0.035 in. guidewire
Blue	=	IC-7 #7F, 0.004 in. guidewire
White	=	IC-8 #8F, 0.044 in. guidewire



## CONCLUSION

Materials for organizing and managing the basic functions of a cardiac catheterization have been fully outlined in this report. In addition, it is important for the supervising physician to realize that his attitude toward training personnel and his interest in their performance of duties will strongly influence the overall function of the laboratory. People invariably perform better when they are properly trained and when their duties are clearly outlined. Besides being able to accomplish difficult cardiac catheterization techniques, the physician will find it very advantageous to know the behind-the-scene functions in the laboratory. A better understanding of the supporting activities will enable the supervising physician to teach and direct his personnel to support him most effectively.

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